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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

MITIGATING DECISION-MAKING PARALYSIS DURING CATASTROPHIC DISASTERS

by

Terrence J. Winters

March 2011

Thesis Co-Advisors: Richard Bergin
Christopher Bellavita

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Using grounded theory methodology on disaster cases, and leveraging the theories and processes of Drucker's business model, the military decision-making process (MDMP), the observe orient decide act (OODA) loop, and recognition-primed decision (RPD), making model from the fields of cognitive, social, and decision sciences, a descriptive decision process model emerged. Catastrophic disaster decision-making model (CAT D^2M^2) is a simple and flexible process that can assist emergency managers in mitigating decision-making paralysis so that lives, the environment, and the economy can be sustained during catastrophic disasters. It is anticipated that the findings and process model from this thesis will contribute further to the research on decision-making; specifically during catastrophic disasters.

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MITIGATING DECISION-MAKING PARALYSIS DURING CATASTROPHIC DISASTERS

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ABSTRACT

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Using grounded theory methodology on disaster cases, and leveraging the theories and processes of Drucker's business model, the military decision-making process (MDMP), the observe orient decide act (OODA) loop, and recognition-primed decision (RPD), making model from the fields of cognitive, social, and decision sciences, a descriptive decision process model emerged. Catastrophic disaster decision-making model (CAT D^2M^2) is a simple and flexible process that can assist emergency managers in mitigating decision-making paralysis so that lives, the environment, and the economy can be sustained during catastrophic disasters. It is anticipated that the findings and process model from this thesis will contribute further to the research on decision making; specifically during catastrophic disasters.

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I. INTRODUCTION

A. INTRODUCTION

As an emergency manager at the World Trade Center (WTC) on September 11, 2001 (9/11), I experienced first-hand the aftermath of terrorists flying two aircraft into two large buildings, leading to their collapse, which personally resulted in an overwhelming situation. Wrought with high levels of uncertainties and low levels of information, it was difficult to understand the situation and make sense of what was unfolding. Like many other first responders to the WTC, this was unlike any other event they and I had experienced (McKinsey Company, 2002, p. 40). As a result of having limited decision-making abilities, in the decision-making environment, which has limited information, a quickly evolving event, and a high demand for decisions on emergency management operations, my decision-making temporarily became paralyzed.[1] Paralyzed in the context of this thesis implies that the decision-making process became temporarily disorganized, resulting is a situation where decision-making became less efficient; however, decisions were eventually made.

To show that my experience at the WTC was not the only situation where decision making became disorganized at an overwhelming situation, consider Hurricane Katrina. During Katrina, conflicting and vague information resulted in "the failure to order timely mandatory evacuations [which] led to an incomplete evacuation" (United States House of Representatives [HR], 2006, p. 2). In addition, a "blinding lack of situational awareness and disjointed decision-making compounded and prolonged Katrina's horror" (HR, 2006, p. x). This, too, was a situation that demonstrated limitations, such as when the decision-making environment has inadequate information and the ability of the decision maker does not meet the demands; decision-making can become paralyzed.

[1] The author of this thesis was a lieutenant with the New York City Emergency Medical Services assigned to the New York City Mayor's Office of Emergency Management as an emergency manager at the WTC during the 9/11 terrorist attacks.

In spite of the documented instances in what could be called decision-making paralysis, during both of these disasters, decisions were eventually made, some effective and others ineffective. For example, during the WTC operations, there were effective decisions made on building evacuations (National Commission on Terrorist Attacks upon the United States [9/11 Commission], 2004, p. 305), which resulted in lives being saved. During Hurricane Katrina operations, there were ineffective decisions made on nursing home evacuations (HR, 2006, p. 115), which resulted in lives lost. Perhaps it was because both of these disasters where beyond what had been experienced by decision-makers in the past or that these disasters were simply overwhelming in scope.

From an emergency manager's perspective, because of the lives lost and the negative effects to the environment and businesses, both disasters could be categorized as catastrophic disasters. This perspective is depicted by the Federal Emergency Management Agency (FEMA) in the *Catastrophic Incident Annex* as, "any natural or manmade incident, including terrorism that results in extraordinary levels of mass casualties, damage, or disruption severely affecting the population, infrastructure, environment, economy, national morale, and/or government functions" (Federal Emergency Management Agency [FEMA], 2008, p. 1). Both the terrorist attacks at the WTC and Hurricane Katrina fit the catastrophic disaster profile, and as a result both required decision making by emergency managers at a different level than any other disaster to preserve life, the environment, and the economy.

To better understand a catastrophic disaster and that decision-making is different during one of these events, it is important to distinguish this rare type of event from a frequent emergency or a routine disaster and why decision making is so different. In a paper differentiating between the three, Quarantelli (2006, p. 2) states that "disasters" are qualitatively different from everyday community emergencies; so are "catastrophes" a qualitative jump over "disasters," meaning catastrophic disasters "require some different kinds of planning and managing than do even major disasters" (2000, p. 2). By framing and defining a catastrophic disaster, it can be concluded that the WTC and Hurricane Katrina disasters had a significantly different environment than emergencies or routine disasters—an environment that produces overwhelming circumstances whereby situation

awareness is low, and there are high levels of uncertainty. Yet emergency managers were still expected to make decisions on problems at a much different level, and therefore required a much different decision-making approach.

The types of problems that need decisions in a catastrophic disaster are not everyday, routine problems, but the problems and issues are unique and important (McCaskey, 1982). They can be classified as "wicked" problems as opposed to "tame" problems. Unlike tame problems, where there is a mission and a solution that is clear, wicked problems are ill-defined, "distinguished by interconnections to other problems, and have uncertainties in a dynamic environment" (Lyles & Thomas, 1988, p. 131). They do not have a true or a false answer and cannot be evaluated immediately for effectiveness (Rittel & Weber, 1973, pp. 160–163). For example, in a wicked problem such as the decision to evacuate lower Manhattan on 9/11, a decision such as this creates other decisions such as where evacuees will go and how will they get there, and the decision to evacuate cannot be quickly reversed, indicating that exercising decision-making contingencies during a catastrophic disaster is not an option. In addition, if not acted upon quickly by making a decision, wicked problems could have cascading consequences to other emergency management operations related to life, the environment, or the economy.

In summary, emergencies or routine disasters are significantly different than catastrophic disasters. As a result, catastrophic disasters contain wicked problems never before experienced by the emergency manager. For this reason, the emergency manager is limited by stressors such as the ability to recall past experiences, the ability to process vague information in a short time period, and lack of time to gather the appropriate information from the disaster environment. Therefore, the lack in the decision maker's abilities, and the quality of information or the time needed to gather the information from the decision-making environment contributes to decision-making paralysis. Regardless, emergency managers are still expected to make efficient and effective decisions.

B. PROBLEM STATEMENT

Emergency managers may be able to recall on experiences from past emergencies or routine disasters to make decisions, but few have been through a catastrophic disaster and can draw from such an event. During catastrophic disasters the ability to recall on past experiences to form recognizable patterns is not readily available, and intuition to make decisions may only serve up to a certain point, thereby causing limits to decision-making. As experienced on 9/11 and learned from the Katrina Report (HR, 2006), catastrophic disasters produce environments where situational awareness is low and high levels of uncertainty and equivocality exist. As a result, due to decision-making limitations and an environment wrought with information inadequacies, decision making can become paralyzed. This thesis considers mitigating decision-making paralysis and the absence of research given to this topic; specifically during catastrophic disasters.

Reading through the National Response Framework and appendices, the National Incident Management System, the 9/11 Report or Katrina Report provides little guidance for emergency managers on decision-making or mitigating decision-making paralysis. In addition, the education provided to emergency managers on the subject of decision-making is inadequate. For example, FEMA's Emergency Management Institute is limited to one course, "Decision-making and Problem Solving," as part of its Independent Study Program series (Emergency Management Institute, 2005). The consequence of a lack in guidance and training in decision making is a void in recognizing and understanding how important decision making is and the significance in mitigating decision-making paralysis during catastrophic disaster operations.

C. RESEARCH QUESTION(S)

This thesis focuses on decision-making limitations that can lead to decision-making paralysis during catastrophic disasters and the processes which describes how decisions in these types of situations are made. The limitations include the decision-maker's abilities and situation awareness when making decisions on the evacuation of at-risk populations, the decision to significantly alter disaster operations, or any other decision needed to preserve life, the environment, and the economy. To better

understand decision-making limitations leading to and mitigating paralysis, the overarching question is: How can a new model be designed to mitigate decision-making paralysis when the experience and situational awareness of the decision maker is low and the disaster environment has high levels of uncertainty and equivocality? In seeking to develop this new model, the following sub-question will be addressed: How can the new model leverage elements of existing decision-making models to mitigate decision-making paralysis?

D. SIGNIFICANCE OF RESEARCH

This thesis will begin the discussion of decision making during catastrophic disasters. Specifically, the intent is to identify which decision-making models are best suited for mitigating decision-making paralysis during catastrophic disasters. The findings from this thesis seek to develop a new descriptive decision process model by leveraging several existing decision-making models. The intent of the new process is to describe how decision-making paralysis may be mitigated when addressing important disaster management issues such as the life safety concerns of first responders and the public, and decisions leading to a strategic change in disaster operations. Pending the findings of this study, the author anticipates that this thesis will contribute to the research on decision-making and motivate additional inquiries into how decision-making processes developed for use during catastrophic disasters may be utilized by emergency managers in other situations.

E. CONCLUSION

This thesis considers decision-making paralysis and the absence of research given to the topic; specifically during catastrophic disasters. Analyzing catastrophic disaster case studies, reviewing decision-making literature, and evaluating four existing decision-making models creates an opportunity to contribute to the research on decision making. In addition, in combination with the personal decision-making experience of the author,

the research question is answered by providing a new process model for consideration to the research area of decision making to mitigate decision-making paralysis during catastrophic disasters.

II. THE 9/11 WTC DECISION-MAKING EXPERIENCE

By following the timeline from the 9/11 report (2004), at 8:46 a.m., the first hijacked plane flew into the North Tower of the World Trade Center (9/11 Commission, 2004). At the same time, while walking out of 7 WTC (the New York City Office of Emergency Management (OEM) offices and the emergency operations center) was the first visual I had that something had happened on the opposite side of view (south side) to the upper floors of the North Tower. Hearing the loud explosion and seeing the resulting destruction and fire to the north side of several of the upper floors of the North Tower created a series of emergency management issues requiring decisions.

The first decision I had to make was to either stay at street level (Vesey and Church Streets) or go back up to the 23rd floor of 7 WTC into the emergency operations center (EOC). Because of the vantage point from the south, it was unclear that an airplane had flown into the North Tower. The only recognition that I could make was a loud noise and a fire. It was an explosion and limited to the North Tower. I made the decision to return to 7 WTC and report into the EOC; however, once inside the EOC, I was given instructions to report to the New York City Police Department (NYPD) command post at Church and Vesey Streets.

At approximately 9:00 a.m., while I was standing at the NYPD command post with senior management from OEM, reports began coming over the two-way portable radios that it may have been an airplane that flew into the North Tower, and that there was a second airplane headed our away. Along with senior OEM staff, the decision on whether to evacuate OEM staff from the 23rd floor was considered. As the city's command center, the EOC would be needed to coordinate and facilitate emergency management operations for this unfolding event; however, it was still unclear and unconfirmed that a hijacked airplane had flown into the North Tower, and it was still unclear and unconfirmed that a second airplane was headed to the WTC. From the south-side vantage point, which I had at Church and Vesey, it looked like only the upper floors of the North Tower were on fire and the incident was limited to the North Tower.

At that moment, there was inadequate information on the current situation, confusion on what had happened, and uncertainties on what was being reported to happen. From a personal perspective, the decision to evacuate the EOC stalled. It was unsure that the OEM staff would be better off in the building, safe from falling debris, or evacuated out of 7 WTC in case the incoming airplane would fly into 7 WTC. However, decisions were being made by other OEM senior staff inside the EOC to evacuate, which occurred safely at 9:30 a.m.

At 9:03 a.m., the second hijacked plane few into the South Tower of the World Trade. While still at the corner of Church and Vesey, seeing this airplane fly into the South Tower and witnessing the devastation it produced, the situation had become overwhelming. After fleeing the area because of falling debris as the second airplane flew into the South Tower, there was still a disaster to manage with decisions to be made. There were decisions I was tasked with making, such as where the emergency management response vehicles would stage, and where an OEM forward command post would be located. However, the incident was still evolving; there was confusion, limited information and uncertainties; and the decisions I was to make were not being made.

Decision-making at this point was limited to the life-safety of first responders. This included my decision to move a NYC Emergency Medical Services (EMS) crew setting up triage and treatment area away from where debris from the North Tower was falling. This illustrated that not all decision-making was paralyzed. Decisions on the immediate situation were being made. In other words, I was able to make decisions based on what could be seen as it was happening; however, other decisions, such as which roadways would be prioritized for access and egress routes for incoming first responder vehicles and which buildings in the WTC complex needed to be evacuated, were indecipherable because the information needed to make this decision was unobtainable at the time. At this juncture, the incident continued to be dynamic and unfolding.

At approximately 9:15 a.m., at one of the Fire Department of New York (FDNY) command posts on the west side of West Street in front of the World Financial Center (WFC), while seeking information to make the decisions on first responder vehicle access

and staging, I became involved in an interagency discussion regarding the evacuation of lower Manhattan. To coordinate this level of decision making required information on the transportation resources that would be needed to effectuate the evacuation, roadway conditions, which direction evacuees would head in and where they would safely go. However, the two-way portable radio frequencies that would be used to gain that information were clogged with priority messages from police and fire rescue operations, resulting in a circumstance where gaining information for situation awareness was impossible.

In the interim, "at approximately 9:30 a.m., a senior OEM Official ordered the evacuation of the facility after a Secret Service agent in 7 WTC advised him that additional commercial plans were not accounted for" (9/11 Commission, 2004, p. 305). This decision is evidence that given specific information a decision can be made.

At 9:59 a.m., while I was attempting to address the request to coordinate the evacuation of lower Manhattan, the South Tower of the World Trade Center collapsed. At this point, after I sought refuge in an underground garage at the WFC, the debris from the South Tower collapse had cut off access to West Street. This resulted in being confined to the WFC underground garage with other first responders. At approximately 10:15 a.m., once myself and the others confined to the garage found our way out, while walking along the rear of the WFC, at 10:28 a.m., the North Tower of the World Trade Center collapsed. During this period, what limited information I had obtained to make decisions was irrelevant, and there was no decision on emergency management operations being made. The catastrophic destruction of the two airplanes flying into the towers and collapsing was something I never before experienced.

Figure 1. Towers (From Wired New York, 2011)

The decisions from the time when the first plane flew into the South Tower and until the second tower (South Tower) collapsed where limited; yet remarkably certain decisions were made. What enable some decisions to be made and others to become paralyzed to the point where the decisions were ineffective? Was the decision by the senior OEM official to evacuate the EOC made based on the information readily available? Was the decision I made to move the EMS crew away from a falling debris area based on information that could obtain immediately? Was the inability to make a decision on which routes first responder vehicles would use because the situation was wrought with uncertainties? This thesis attempts to discover high-level concepts that can be used to develop a decision-making process model so that decision-making paralysis is mitigated.

To answer the research question of how can a decision-making model best mitigate decision-making paralysis during a catastrophic disaster, the literature review focused on the areas of cognitive science, social science, decision science, and organizational studies. Theories on decision-making from these areas have evolved by studying how humans make decisions and the steps involved. For example, there is research that describes what people actually do (descriptive) and what people should do (normative or prescriptive) when making decisions. The findings from the descriptive and normative research areas helps to account for decision-making limits and capabilities that are valuable in understanding decision-making theories and processes developed from the various research areas.

Herbert Simon (1959) and James March (1994) are two examples of researchers who have studied humans in actual decision-making settings, such as chess masters and business executives. Their studies have lead to developing prescriptive decision-making theories based on the principle that the decision maker has a tendency to acquire manageable rather than optimal amounts of information, and that it is difficult for decision makers to identify all possible alternative solutions (Simon, 1959). Prescriptive theories developed by Simon and further researched by March on "satisficing," "bounded rationality," and "judgmental heuristics" have spurred additional exploration into how people make decisions. For example, Nutt (2002) analyzed the sequences of mistakes and poor judgments that led to 15 well known decision-making debacles from the private and public sectors. By studying the decisions people actually made, he suggests that a decision, in order to succeed, should follow five prescriptive stages: "collect info, set a direction, systematically search for ideas, grade those ideas against the chosen direction, and manage barriers" (Nutt, 2002, p. 41). Noted organizational behavior theorists Karl Weick and Kathleen M. Sutcliffe also provide prescriptive information from their research on the importance of making sense of a situation prior to making a decision (2005). Their research examines how circumstances can be talked into existence through words and salient categories and turned into a situation (Weick & Sutcliffe, 2005, p. 409). David Snowden has contributed to this theory by developing a sense-making tool to categorize a situation (1999). The Cynefin model suggests ways a person frames or

places the situation and information into one of five areas of simple, complicated, complex, chaotic, disorder (Snowden, 1999) to make sense of the situation.

However, theories on decision-making and sense-making such as Simon's, March's and Snowden's are based on studies of experienced decision makers, such as in chess matches or in business settings, where low situational awareness, high uncertainty, and equivocality can be mitigated. To bring the most relevant descriptive and normative decision-making literature forward, research conducted on situations closest to the context in which an emergency manager could potentially encounter decision-making paralysis was sought.

For example, Weick's 1993 study of the Mann Gulch fire in 1949 is a descriptive study of smokejumpers in a situation where experience was low and information unavailable, yet decisions needed to be made. Using reports from the surviving smokejumpers, Weick explored how a series of poor decisions were made (1993). He focused on smokejumpers inability to connect what had happened in their past experiences during forest fires, and why they were unable to make sense of what was occurring in the fast moving forest fire. Weick's descriptive research into this confusing circumstance puts forward the notion that when there is difficulty in making a decision, stepping back to make sense of the situation may be an effective step. Additionally, Klein (1998) has conducted research in real-world environments describing subjects in what they actually do when making decisions. His descriptive study of firefighters and soldiers in real-time situations illustrates how they handle difficult decisions under conditions such as time pressure and uncertainty by using mental models that have lead to developing a naturalistic decision-making model known as the "Recognition Primed Decision-making Model" (RPD).

In summary, March and Simon studied chess players and executives to develop their decision-making theories. March states that there is not always perfect and complete knowledge when making a decision, that "people can make rational decisions if only they can gather enough information" (1994, p. 15). Simon's findings have lead him to describing decision-making limits as "bounded rationality," and he describes the use of prescriptive measures such as the use of rules-of-thumb or "heuristics" when making

decisions (Simon, 1959). In continuing in the prescriptive area, Klein's RPD model emerged while observing how firefighters and soldiers instinctively make decisions through mental recall. His research reveals that experience and the ability to recall on experience lends itself to effective decision-making; however the subjects in his studies were observed making decisions in their operational setting based on how they would normally make a decision; which is by recalling on a past experience, or recognition, to make sense or size up the situation as a step in making a decision. The chances of decision-making paralysis were minimal if not absent. Weick, Sutcliff, and Snowden have raised the importance of sense-making by developing theories and models that prescribe ways to recognize a circumstance and through categorization turn the circumstance into a situation that can be understood and addressed. However, there is an absence within the current research that addresses mitigating decision-making paralysis during a situation such as catastrophic disasters.

The research question is framed to illustrate that there are limits to decision making; especially when the person's experience is low and the situation (catastrophic disaster) is wrought with high levels of uncertainty and equivocality, thus causing decision-making paralysis. The literature reviewed is absent in addressing this question or the issue that decision-making paralysis is a phenomenon that needs to be better understood. Therefore, by using grounded theory as a research methodology, the intent is to leverage existing decision-making models to present a novel decision-making process as it applies to the management of catastrophic disasters that can be used to stimulate the emergency manager's decision-making abilities when decision making becomes paralyzed.

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III. METHODOLOGY

In seeking to answer the main research question: How can a model be designed which mitigates decision-making paralysis during a catastrophic disaster when experience and situational awareness of the decision maker is low and the disaster environment has high levels of uncertainty and equivocality? Grounded theory research (Glaser & Strauss, 1967) is used to better understand how decisions are made during catastrophic disasters. Glaser and Strauss' (1967) grounded theory approach is the systematic method of qualitative analysis used in this thesis to develop a substantive theory in the form of a theoretical model which describes how decisions are made during catastrophic disasters.

Using grounded theory research to examine a set of disaster cases was selected because the topic of decision-making in the context of catastrophic disasters is an unfamiliar and under-researched concept requiring grounded exploration (Gioia, Thomas, Clark, & Chittipeddi, 1994, p. 367).

A. CASE SELECTION

Using grounded theory, to begin discovering how decisions are made during a catastrophic disaster, cases on past disasters were purposely selected. The cases selected for this research provide data from a first responder/decision maker viewpoint. For this reason, the narratives are taken seriously, and any prior views on decision-making during a disaster are not used during the data collection.

Each disaster case was selected for theoretical, not statistical reasons (Glaser & Strauss, 1967) to "best support the development of the theoretical framework" (Locke, 2001, p. 55), which in this study, is on decision making during a catastrophic disaster. The disaster cases do not contain any decision-making models. The cases selected are similar in that they evolve around a catastrophic disaster situation; however, because they are of different types (hurricane, terrorist attack, fires), they each have a different dynamic that was examined for any differences in decision making. They are accounts of

emergency managers in situations where the circumstances contained high levels of uncertainty and equivocality; such as during a category-5 hurricane or any other emergent disaster situation that requires decisions.

B. THE SAMPLE CASES

Data was collected by reviewing the accounts of several disaster cases (Howitt & Giles, 2009) that are descriptive and exploratory in nature. The cases selected represent a research strategy likened to an experiment or a simulation (Yin, 1981). The distinguishing characteristic of using cases, as opposed to interviews, is that it examines: "(a) a contemporary phenomenon in its real-life context, especially when (b) the boundaries between phenomenon and context are not clearly evident" (Yin, 1981). In other words, the cases selected are actual accounts of what occurred during disasters, and the study of decision-making during the disasters was not the main reason for the authors writing the cases.

The approach in using cases as a research strategy is to focus on understanding the dynamics in decision-making within a single setting (Eisenhardt, 1989), which is during a catastrophic disaster situation. After conducting research on 10 disaster cases, six were found to contain narratives on issues related to the life safety of first responders or the public, lead to a strategic change in disaster operations, or described difficulties in mitigating the effects of the disaster. Again, the cases selected did not contain any concepts or models on decision-making; they were chosen because they were catastrophic and, therefore, contributed to developing decision-making concepts and answering the research question.

The six catastrophic disaster cases are as follows:

1. The Baltimore Tunnel Fire of 2001
2. 9/11 Pentagon Emergency
3. 9/11 World Trade Center Terrorists Attacks—Fire Department Operations
4. 9/11 World Trade Center Terrorists Attacks—Emergency Medical Services Operations

5. The 1999 Hurricane Floyd Evacuation in Florida
6. The 2003 San Diego Firestorm

C. DATA ANALYSIS PROCESS

Once the six catastrophic disaster cases were selected and read, notes were taken to identify the key issues of the case and to begin the process of coding decision-making actions. All six cases were independently analyzed line-by-line to research for common themes on how decisions were made. Using Glaser & Strauss's (1967) constant comparative method, the data generated from one case was compared to the data from the other cases. As this iterative process progressed, notes evolved into codes, codes were developed into core categories that were then sorted further as theory began to emerge.

To illustrate, to extract each decision-making point from the case study, each section was read line-by-line looking for either a decision made, information leading up to a decision, or a decision outcome. Questions were asked such as: "Did the decision have a life-safety concern, or was the decision made on an emergency management operation?" The sections of the case study that answered these types of questions were extracted and noted for its decision-making. Once the first case was completed, the subsequent cases were compared to the preceding cases using the same process of reading and note taking.

To distill the notes of all the cases further, and to continue building theory, the information gathered from the note taking was placed into an "informant's code" grouping. The informant's codes are the actual words from the cases the decision makers used on what prompted the need for a decision, and what transpired as the decision was made. To arrive at the informant's codes categories, the notes were reviewed with the researcher asking: "Had the decision maker experienced something like this in the past, or did the decision maker need or have enough information to make the decision?" For example, using the decision to evacuate the at-risk population during the Baltimore Tunnel Fire, the fire chiefs were quoted as saying, "A situation that had no parallels in their collective experience" (Scott, 2004, p. 203). This quote was placed into the informant code category because it answered the question had the decision maker

experienced something like this in the past? During the entire note taking and coding process, the data generated by each case was continually compared to the other cases looking for trends in data and the emergence of theory.

It was noticed that the data emerging from the note taking and coding process was forming the beginning of a substantive theory that would become a descriptive decision process model. This was that the decision makers were seeking specific details in making their decisions. Furthermore, the details needed for the decisions were either sought out through situational awareness or required the decision maker to recall a similar situation to make the decision. This preliminary theory was used to revisit each case study to make comparisons on the decision points as a way of grounding the theory and moving forward with the process.

With a descriptive decision process model beginning to emerge and to ground the data further, another grouping was established called second order categories or "core categories" (Glaser & Strauss, 1967, p. 191). The second order categories were developed by looking at each of the informant's codes to see if the information on the decision was based on needing situation awareness or making observations prior to taking action on a decision. In this instance, the codes situation awareness and making observations prior to taking action on a decision were turned into a core category named sensemaking. The following seven categories emerged from the review of all the cases:

1. Assessment
2. Comparative evaluation
3. Constraints/Limitations/Stress
4. Pre-arranged
5. Predicative estimations
6. Recognition
7. Sense-making

The data and theory obtained in the process of coding and comparing the decision points was continually reviewed and compared to further identify any unique attributes the decision makers used in making decisions. The comparative analysis on situation awareness and observations produced a further notion that there is an emphasis by

decision makers in disaster situations placed on pre-decision actions. When there was a recurrence of core categories from the cases, the research stopped. It was determined that saturation of the data was met (Glaser & Strauss, 1967). At this point, there was enough data to clarify the parameters of the emerging descriptive decision process model.

In summary, by doing comparative analysis on the data and theory, a pattern emerged across the cases that lead to recognizing decision-making relationships. This "theoretical sensitivity" (Glaser & Strauss 1967) was used to better understand decision-making, specifically during a catastrophic disaster. As the pattern formed, the formulation of a descriptive decision process model materialized that can be applied to catastrophic disasters. With the descriptive decision process model identified, the decision-making literature that focused on what people actually do when making a decision (descriptive), and what people should do (normative) was revisited. The substantive theory that emerged during the constant comparison stage became connected to the descriptive decision process model found during the literature review. Because of this, a triangulation was formed, and the research on the cases was affirmed to be grounded.

D. CONCLUSION

The final step is to take the theorized decision-making process and evaluate it against the research question and against the grounded theory methodology. Questions that will be asked are: if the descriptive decision process model is a practical solution, is applicable to a catastrophic disaster situation, is easy for the emergency manager to understand and use, and provides a basis for future decision-making research. Furthermore, that the decision-making model being theorized is based on making sense of the situation and enhancing the decision maker's abilities to ensure that decision-making does not become paralyzed.

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IV. CASE OVERVIEW AND ANALYSIS

A. CASES REVIEWED

All of these disaster cases selected were catastrophic. In other words, catastrophic disasters such as these were beyond the normal scope of what decision makers had experienced in "community emergencies" and "disasters" (Quarantelli, 2000). Therefore, these disasters presented something new and complex to the decision makers. The emergency managers, fire fighters, and police officers in the cases were not designated as the decision makers for the disasters, nor was it noted anywhere in the disaster cases that these individuals received training or had specific expertise in making decisions. Simply because of the position the individuals either found themselves in during these disasters, or because it was their responsibility as supervisors, they became decision makers.

The catastrophic disaster cases are summarized to present an account of what transpired during each of the disasters as well as to analyze the decision-making that took place.

1. The Baltimore Tunnel Fire of 2001

In July 2001, a CSX freight train carrying paper products, plywood, soy oil, and chemicals derailed in a tunnel underneath the downtown area of Baltimore, Maryland. The initial response to the incident was thought to be a routine call by the fire department because reports of smoke emanating from the tunnel were a common occurrence, as trains would usually omit smoke in the area of the tunnel. Because it was a train on fire in a tunnel and it was carrying chemicals, if it exploded it had the potential to become a catastrophic disaster. To complicate the situation, a large water main break also occurred in the tunnel, the roadways above the tunnel were full of commuters, there was a school, concert hall, high-rise apartment building, and a baseball game at Camden yards would start in a few hours. Yet still needed were critical decisions on fire suppression operations, evacuations, roadway shutdowns, and venue closings.

This was a situation that city officials "had no parallels in their collective experience" in managing (Scott, 2004, p. 203). Not being able to remember a past event or past practice that fit this situation contributed to some of the difficulties officials had to make on decisions, such as evacuations and predicting or deciding how fire suppression operations should be conducted. As a result of the incident being underground and out of full-view from the fire chiefs, situation awareness was low. Therefore, the fire chief's ability to make decisions was constrained resulting in decisions being made with what information was available at the time. It was restricted and limited because of having to wait on reports from firefighters in the tunnel, information from the waybill, and the limited visual they had of the black smoke emanating out of the tunnel. In addition, the decisions on evacuations, roadways shutdowns, etc., would create secondary problems; thus, additional decisions such as where would evacuees shelter and which roadways would take the diverted traffic. These are not simple decisions to make and are time consuming when time is limited.

2. The 9/11 Pentagon Emergency

At 9:37 a.m. on September 11, 2001, (9/11 Commission, 2004) a Boeing 757 hijacked by terrorist was intentionally crashed into the Pentagon - a U.S. military establishment which placed the incident into the realm of national security crisis. In this case first responders were faced with a catastrophic situation where initial information about what had occurred at the Pentagon was unclear. They did know about the plane crashes into the World Trade Center; however, they did not know if additional airplanes were on target for the Pentagon. The combination of a plane crash, fire, and building collapse at a single location presented the Arlington County Fire Department with a series of incident command challenges to organize responders and investigators (Varley, 2003, p. 235–234).

In studying the case it becomes apparent the fire department personnel had never before encountered a situation of this scale requiring a host of decisions to maintain order and sustain rescue operations. In this situation some of the fire chiefs were noted to be veterans of the department with many years of service (Varley, 2003, p. 237). As a

result, their capacity to relate similar incidents (fires, building collapses, plane crashes) could serve to increase their recognition abilities; however, the environment they were in played a role in their decision-making abilities. For instance, on evaluating the scene to make decisions on fire operations, one of the chiefs stated that "the sheer size of the Pentagon made it hard to get a comprehensive picture of the damage" (Varley, 2003, p. 237). This is an example where the decision maker had experience to make decisions yet the environment, the devastated Pentagon site, became a factor in the decision-making process.

3. 9/11 World Trade Center Terrorist Attacks—Fire Department and Emergency Medical Services Operations

At 8:46 a.m. on September 11, 2001, (9/11 Commission, 2004) the first of two planes hijacked by terrorists flew into the World Trade Center (WTC) buildings. The incident consisted of two passenger airplanes crashing into two occupied high-rise buildings. The buildings eventually collapsed onto several other large buildings within a 16-acre site, killing first responders and civilians, destroying first responder vehicles, utilities, roadway infrastructure, and subway transportation lines. The response to the incident was the largest New York City had ever encountered. These two cases account for what the Fire Department of New York City (FDNY) and Emergency Medical Services (EMS) did to manage the incident as it unfolded, including information leading up to decisions on evacuating first responders and civilians out of the north tower and requesting mutual aid assistance.

Because the magnitude of the incident required such a large response of FD and EMS resources, and many of those resources including the two-way radio communications system were affected during the collapse (McKinsey Company, 2002), decisions made by both agencies were made with limited information and situation awareness. Ambiguity and inconsistency in the information at the WTC site influenced decision making to several operational areas, such as evacuations and staging of response vehicles. In addition, although plans that would normally be used as decision-making tools on decisions such as the best access and egress routes for emergency vehicles, or

where to position a command post did not exist for an incident of this magnitude. However, decisions were made on staging locations and command post locations by decision makers using what little information they were able to obtain at that time.

4. The 1999 Hurricane Floyd Evacuation in Florida

On September 13, 1999, Hurricane Floyd approached the Florida peninsula. Emergency managers at the state level and from the communities along the coast predicted to be impacted called for an evacuation; however, the memory of Hurricane Andrew a few years earlier reminded residents of the devastation a hurricane this size could bring. As the evacuation decision for Hurricane Floyd was made by emergency managers, residents not needing to evacuate "shadow evacuated." The result was roadway congestion that if Hurricane Floyd did remain as large as predicated and hit the coast, residents in transit would have been exposed to high winds and water while stuck in traffic on Florida highways (Husock, 2004, p. 283).

This case depicts emergency managers confronted with what they thought they had planned for, yet the decision to evacuate resulted in a wide-spread traffic condition they had not foreseen. The decision to evacuate was based on weather information at the time, historical knowledge of recent hurricane evacuations, and assumptions derived from hurricane evacuation behavioral studies conducted on residents along Florida's coast. The evacuation decision was made; however, the decision makers did not take into account what the effects would be to the roadways as a larger than expected number of evacuees attempted to flee the area. This disaster case illustrates that decision makers managed to make decisions during a stressful situation containing conditions such as a large number of people stuck on evacuation roadways while a strong hurricane approached their area.

5. The 2003 San Diego Firestorm

Beginning on October 2003, and lasting for a two-week period, southern California was subjected to numerous wild land fires. Fifteen of the fires became major incidents or "mega fires" that endangered significant numbers of people and large

amounts of property (Lundberg, 2004, p. 305). Those that became collectively involved in managing these incidents encompassed firefighters, sheriffs, military officials, and elected officials. Those in the decision-making positions were faced with fires that outstripped fire suppression capabilities too quickly, fires that spread in a way never before experienced, and fire incidents absent full situational awareness. Decisions ranged from the evacuations of residents to the management of the fires that included where the fire suppression resources would come from, and where they would be deployed.

An interesting factor in this case was how the two-week duration of the fire storm seemed to work to the advantage of the decision makers. As a result of prolonged operations, time was available for discussions on strategy level decisions, foresight on decisions was made, situation awareness was afforded the opportunity to evolve, and depending on the problem, decision makers were introduced along the way to provide comment on policies and procedures. To illustrate, on the decision to activate military aircraft to assist with fire suppression for the Cedar Fire, elected officials, and those in charge of firefighting operations had time to reference federal policies. As time evolved additional elected officials became involved and deliberations ensued prior to making decisions on the use of military aircraft. It was a decision never made before for an incident which decision makers had never experienced (Lundberg, 2005, p. 322). There were no quick decisions made in this instance. Although extended operations appears to have played a factor in decision-making by way of recognition building and heightening of situation awareness, there were still several quick spreading fires within the two-week period that required quick tactical decisions.

There was very little time to make decisions on which areas to evacuate or the locations to send fire crews to as fires spread quickly. For example, realizing the fire in combination with the Santa Anna winds could compromise a route, in the decision not to send fire crews in on that route, decision makers used quick foresight into what the outcome of the decision would result in. They used current weather information and intuition to predict that sending crews in on the route would jeopardize their safety. In this instance, the decision-making environment and the decision maker's abilities merged

to make the correct decision. They made use of textual information from the fire and weather reports to build situation awareness for their environment, and their judgment to make the decision with a successful outcome.

B. CONCEPTUAL CATEGORIES DISCOVERED

Decisions were made in each of the disaster cases; however, at times the process of making a decision was not clear. To recognize the decisions and how they were made, as mentioned in the method section, the narration of those involved with the disaster was transformed into recognizable decision-making codes or analytic codes. For example, notes were taken on what the decision makers were quoted as saying. The quotes were then converted into a description to make it easy to understand for the next step. The analytic codes were then refined into second order categories (see Table 1). A complete listing of the informant's codes, analytic codes, and second order categories (categories) can be found in the Appendix.

Table 1. Second Order Categories and Descriptions

Second Order Categories	**Description**
Assessment	**Examination** Separating a complex topic into smaller parts to gain a better understanding.
Comparative Evaluation	**Comparing** Continually measuring options against the current information.
Constraints/Limitations/Stress	**Bounding** Identifying limitations and constraints to actions.
Pre-arranged	**Targeting** Resorting to a set of predetermined rules or standards.
Predictive Estimations	**Speculating** Forecasting, estimating, and hypothesizing.
Recognition	**Recall** Remembering from past events or past practices, assimilating to the situation, historical reflection.
Sense-making	**Diagnosing** Define the situation and making sense of the situation by describing, classifying visual, textual, and oral, information.

C. SECOND ORDER CATEGORY DISCUSSION

1. Assessment—Separating a Complex Topic Into Smaller Parts to Gain a Better Understanding

Decision makers were noted as dividing problems into component parts to first gain an understanding of what was occurring, and then seeking out the information still needed to make the decisions. Using the Baltimore Tunnel Fire as an example, the fire chiefs needed to make a decision on evacuations. To make this decision, they were noted as assessing the black smoke emanating from the tunnel and assessing the information contained in the train's waybill; however, this was not enough information to make the decision; they turned to and listened to the advice of their hazardous materials firefighters. Combined, this information provided a better understanding on the decision to evacuate.

2. Comparative Evaluation—Continually Measuring Options Against the Current Information

Certain decisions required the decision maker to contrast what they knew at that moment against the decision that was needed. For instance, although faced with a fire storm that they had never before encountered, using what information they had just learned on the rate of the fire spreading, and what they could see as the fire approached, Sherriff Deputies made a decision to evacuate residents out of the fire's path. They were not trained firefighters, yet they continually weighed what they knew at that moment against what they were faced with to arrive at making a life-safety decision within a limited time period.

3. Constraints/Limitations/Stress—Identifying Limitations and Constraints to Actions

Not all decisions were made without encountering boundaries. Limited information, time pressures, stress, limited experience, and knowledge were all factors which contributed to constraining or limiting decision-making. Using the urgency to make life-safety decisions at the Pentagon on 9/11 as an example, the fire chiefs were

limited in their ability to gain situation awareness of the incident because the site itself was so large. At the WTC incident, the fire chiefs attempting to make decisions on rescue operations were constrained by a lack of reliable intelligence. In addition, due to the catastrophic conditions of the disaster the decision-making environment was stressful for the decision makers.

4. Pre-arranged—Resorting to a Set of Predetermined Rules or Standards

Some of the decisions appeared to require little thought. There seemed to be a logical and systematic way of approaching the decision; almost that the decision did not require much thought. For example, emergency managers faced with making the decision to evacuate at-risk residents from Hurricane Floyd resorted to decision-making based on a pre-determined set of plans. Or, as in the decision to establish a command post inside the lobby of the World Trade Center, a fire chief resorted to a pre-established standard operating procedure. In both of these situations there was a noticeable targeting or seeking of information via a predetermined set of rules to make decisions. Other than remembering there was a plan or standard operating procedures to follow, there was little the decision maker had to do to arrive at a decision outcome.

5. Predicative Estimations—Forecasting, Estimating, and Hypothesizing

Attempting to foresee the outcome of the decisions was noted in some of the catastrophic disaster cases. For instance, the fire chiefs' decision to forego treating the severely injured and instead focus on viable patients at the Pentagon was a decision that required anticipating the most efficient use of the available resources. From the Hurricane Floyd disaster case, attempting to predict what the decision outcome would be was not a direct decision-making function. Rather, it appeared it was a trial and error approach in understanding the situation. This was evident in that the emergency managers expected a specific number of people would evacuate when the orders were finally given. Again, it was a process to evaluate through estimating what the decision outcome would result in.

6. Recognition—Remembering From Past Events or Practices, Assimilating to the Situation, Historical Reflection

Being able to relate a past situation from experience to the current situation was a major factor leading up to making a decision. During Hurricane Floyd emergency managers mentally recalled Hurricane Andrew as a past situation to the current situation of Hurricane Floyd on the decision to evacuate residents; however, the firefighters, chiefs and emergency medical technicians at the WTC incident had nothing to resort back to from their past experiences to make sense of the situation.

7. Sense-making—Define the Situation and Make Sense of the Situation by Describing, Classifying Visual, Textual, and Oral Information

The challenge to frame or place the decision into a category, either through reading something, visualization, hearing something appeared to be a significant factor in leading up to making a decision. During the World Trade Center disaster, visualizing the scene to understand what had occurred, such as what the firefighters had to do when the towers collapsed to place the incident into a perspective, provided them with situation awareness of the destruction. The fire chiefs in the San Diego fire storms gained situation awareness by listening to a report from someone with the most current knowledge on the spread of the fire.

D. GROUNDED THEORY FINDINGS AND EMERGED THEMES

Four influential second order categories that emerged from the catastrophic disaster cases were sense-making, recognition, assessment and pre-arranged. These four categories did not occur at a higher incidence than the others of comparative evaluation, constraints/limitations/stress, or predicative estimations, rather they were found to be significant in making a decision during a catastrophic disaster. However, limits such as experience of the decision maker and the quality of information from the disaster environment were found to have effects to sensemaking, recognition, assessment, and pre-arranged.

1. Sense-Making

To illustrate how sense-making emerged as a decision-making finding, while responding to the Pentagon plane crash, a veteran chief of the fire department heard a vague report "that planes had crashed into the World Trade Center" (Varley, 2003, p. 244). This type of information would be one of the chief's first steps in making sense of what he was responding into at the Pentagon. To continue, upon arrival at the incident, the chief received information that "another hijacked plane was headed their way, there was an explosion at the White House, and that there was a car bomb at the State Department" (Varley, 2003, p. 245). In addition, because of what he knew of two planes into the World Trade Center, "Schwartz thought they [the terrorists] could be planning a second strike on the Pentagon as well, with the intention of killing first responders" (Varley, 2003, p. 245).

During this period, it was evident that from the disaster case research, the situation at the Pentagon was unfamiliar and the information from the environment was uncertain for making decisions. Yet, life-safety decisions were still needed at "an incident the fire department had never before prepared for" (Varley, 2003, p. 246). With the information about the World Trade Center incident in combination with the information he had learned about a plane headed to the Pentagon, and that he thought a second hijacked plane was headed to the Pentagon; the finding is that the chief was making sense of the situation.

Sense-making through situation awareness continued based on what he could visualize such as the destruction to the Pentagon, and what he had heard from the other chiefs concerning rescue operations. With little and uncertain information in this stressful circumstance, the chief's decision-making did not become paralyzed. He made enough sense of the situation to make the decision to evacuate first responders from the building to ensure their life-safety.

This example illustrates that the chief, because he was faced with information limitations, was noted to be increasing sensemaking through an iterative situation awareness cycle to a sufficient point to make a decision. It appears that in this

circumstance where situational awareness was low and high levels of uncertainty and equivocality existed, and there was an absence of recognition to make decisions, the process of increasing situation awareness by continually making sense of the situation contributed to decision-making.

The finding then is that when information was low, and experience did not match the circumstance, repetitively building a story on information from the environment from what could be seen, heard, or read, enhanced the sense-making or situation awareness of the decision maker. As a result of overcoming limitations by making complete sense of the situation, decisions on life-safety and scene operations were made as opposed to becoming paralyzed. Sense-making also appeared to be a step towards categorizing the situation into something simple and manageable and assisted in building immediate experience (recognition) where none existed.

2. Recognition

The disaster cases researched were catastrophic which limited the ability to use the experience from past emergencies or disasters. In the absence of mental recall, sensemaking materialized as a contributing factor towards building a conceptual theory on recognition. This finding of recognition through sensemaking where no recall existed emerged from the Hurricane Floyd, 9/11 EMS, and San Diego Firestorm cases.

Using the decision to use military aircraft during the San Diego Firestorm as a limit on recognition as an example, decision makers were unable to use mental recall at the onset of the disaster. They were noted as saying "it was a decision never made before for an incident which decision makers had never experienced" (Lundberg, 2005, p. 322). At the onset of the firestorm, limited recognition caused decision-making boundaries; however, as learned from the disaster case, recognition accumulated over the two-week period of the disaster so that decisions toward the later part of the incident were made based on what was experienced during the early part of the disaster. This example illustrates that the absence of recognition is a limitation that the decision maker eventually can overcome.

The finding is that to mitigate decision-making paralysis, no matter how inexperienced the decision maker may be, the environment is a source of information that can be used to develop experience. In contrast, there were decisions that did not require a great deal of recognition; therefore, the pre-arranged category emerged whereby preset rules or standard were being used.

3. Assessment

Assessment from the research is described as separating a complex topic into smaller parts to gain a better understanding. To simplify the second order category of assessment, Hurricane Floyd can be used as an example. The emergency managers assessed a hurricane evacuation study (textual data) to determine roadway evacuation clearance times; this is data referencing. They assessed the information they heard about the traffic on the evacuation routes and that it was becoming increasingly worse as the hurricane approached; this is hearing information. They linked and compared the assessed data they had to what they had heard in order to make the next set of decisions on the evacuation. In summary, they conducted an assessment of the textual data and what they heard to assist in making a decision on the evacuation. They did not let the decision-making process become paralyzed.

4. Pre-Arranged

To illustrate from the 9/11 FDNY case, firefighters did not have to spend a large amount of time making a decision on who would be in command of the incident. Due to training on standard operating procedures which outlined the incident command hierarchy, this type of decision required very little thought. In this circumstance, and in other disaster cases where predetermined rules were used, the core category "pre-arranged" emerged as another significant decision-making category. As an additional example where "pre-arranged" emerged as a category, the emergency managers during Hurricane Floyd resorted to hurricane preplans and evacuation behavior studies to make the decision on evacuating the at-risk population.

The "pre-arranged" second order category emerged as a finding to build a conceptual theory that decision makers will resort to a prescriptive process if one is available rather than spend time trying to make sense of the situation or recall a past experience.

E. CONCLUSION

While conducting grounded theory research on the disaster cases it was unclear whether or not decision-making paralysis did occur. It did become evident that decisions were made on life-safety issues and disaster operations; no matter the decision maker's abilities or the disaster environment. Although this finding discounts the problem statement that claims that emergency managers as decision makers will not be able to make decisions during a catastrophic disaster for a number of reasons and paralysis will be present, there still remained an uncertainty on how the decision makers made decisions. However, as mentioned earlier, the disaster cases were selected because they were catastrophic disasters, not because they contained decision-making themes. Therefore, there was no clear evidence from the disaster cases that decision-making became paralyzed. Still, there is a perception from the author's 9/11 experience that decision-making paralysis can occur during catastrophic disasters. This perception has prompted taking the findings from the disaster case research and conducting a second review of the literature; specifically to look into the function of the decision making environment and the abilities of decision maker as a way of mitigating decision-making paralysis. The finding is that despite the experience level of the decision maker, and what little information the decision-making environment can provide, decision-making involves an iterative sensemaking cycle to build information and recognition.

To review, from the author's 9/11 experience, that during catastrophic disasters when situational awareness is low, when high levels of uncertainty and equivocality exist, and there is an absence of recognition to make decisions, decision-making can become paralyzed. That in order to mitigate decision-making paralysis there needs to be a process of carrying out a sense-making and recognition cycle to build experience and

inform the decision maker—a cycle that continues until the decision maker obtains a reasonable or desired level of sense about the situation to make decisions.

As mentioned in the literature review section, the existing decision-making research is absent in addressing decision-making paralysis; specifically during a catastrophic disaster. In spite of this deficiency, the goal in linking the emerged findings to the normative and descriptive findings conducted by scholars in real-time (Klein), using past events (Weick), and by applying theory to a situation (Simon, March, Snowden) is to better understand if the findings that emerged from this study are in alignment with the decision-making research. To achieve this requires revisiting and expanding on decision-making research topics such as satisficing, bounded rationality, heuristics, mental recall, and sensemaking and linking them to recognition, sensemaking, and pre-arranged found during the grounded theory research. In addition, because the emergence of stress as a constraining and bounding factor surfaced across the second order categories of recognition, sensemaking, and pre-arranged, stress will be addressed as an inhibitor in decision-making under pressure caused by time pressures, uncertainties, or ill-defined goals.

V. LINKING THE EMERGED FINDINGS TO THE LITERATURE

A. THE DECISION MAKER AND THE ENVIRONMENT

Scholars such as Simon (1959, 1987, 1979, 1990) and March (1994) both suggest that decision makers have limits. Open and analytical coding of the disaster cases revealed that decision makers were at times faced with limitations both in abilities and from the environment. Regardless, the analysis revealed that decision makers still made decisions. Understanding that decisions will and can still be made with limitations is further supported by the literature on satisficing and bounded rationality from Simon (1979).

Simon (1979) has found from his research that decision makers will choose a solution that meets the minimum requirements or is good enough for the decision; what he calls "satisficing." Additionally, he claims that there are limits to an individuals decision-making abilities; which he terms as "bounded rationality." In a *Harvard Business Review* article on decision-making, the authors quote Simon on his bounded theory as saying "complex circumstances, limited time and inadequate mental computational powers reduce decision-making to a state of bounded rationality" (Buchanan & O'Connell, 2006).

There are two factors being raised on the subject of limits that have also materialized from the grounded theory research. The first is that the person(s) as a decision maker and his or her abilities are a factor in making decisions. The second is that the decision-making environment also becomes a factor in making decisions. Simon used a pair of scissors and a metaphor in his writing to describe the theory of what constitutes bounded rationality as a limitation. He explained, "One blade of the scissors is the cognitive abilities of the decision maker and the other is the structure of the environment" (Simon, 1990, p. 7). This analogy helps in grounding the finding that there are limits to the decision maker's (cognitive abilities) and limits to the decision-making environment; which March and Simon have declare in their research.

To illustrate the limitations point, decision makers during the 9/11 EMS operations were noted as being overwhelmed with high volumes of information thus limiting their ability to synthesize information (McKinsey Report, 2002). In spit of limits in decision-making abilities and in information processing, they still made decisions. Furthermore, while reviewing the 9/11 FDNY disaster case on the decision to evacuate firefighters from the towers due to a possible collapse, the ability of the fire chiefs to make decisions when experience in this type of situation was low and information was scarce came to light as a limitation. For instance, although 32 staff chiefs consisting of senior staff (McKinsey Report, 2002, p. 32) with years of experience were at the incident, they had had never been through a catastrophic incident such as two planes flying into two large buildings. Additionally, the environment had communications and information sharing difficulties (McKinsey Report, 2002, p. 31). Therefore, it can be implicit that the cognitive ability of the decision makers was not sufficient enough, and the environment was not conducive in gaining situation awareness. Regardless, life-safety decisions were made based on limited experienced and limited information.

To expand on decision-making limits further, from Simon (1959), bounded rationality means that the decision maker has a tendency to acquire manageable rather than optimal amounts of information, and that it is difficult for decision makers to identify all possible alternative solutions. Simon does not imply that decision makers are irrational in their decision-making, rather that "decision makers are cognitively and informationally constrained so that an appreciation of what is happening may be partial and the ability to reason is generally good enough, not perfect" (1955, p. 113). Along the same lines, March (1994) states that there is not always perfect and complete knowledge when making a decision, that there are "limitations to a decision maker's attention, memory, and comprehension." March continues that "people can make rational decisions if only they can gather enough information" (1994, p. 15). March also provides insight into whether the information used in making decisions is sufficient or just suitable for making the decision.

Recognizing that when limitations to recognition are present, making decisions does not necessarily require optimal information. That using sufficient rather than

suitable information is a mitigation measure in avoiding decision-making paralysis. In brief, when experience is absent and information scarce, a decision derived from the ability on-hand and the available information is better than no decision at all.

B. DECISION-MAKING SHORTCUTS

Linking Simon's and March's theories on satisficing and bounded rationality substantiates that decision-making can become paralyzed when situation awareness is low and there are high levels of uncertainty and equivocality. To address constraints, such as limitations in mental recall, perhaps because there was nothing to recall or stress has inhibited the ability to recall, Simon's research on "judgmental heuristics" is brought forward. The literature on judgmental heuristics brings to light a finding that emerged from the grounded theory research, which is that decision makers seemed to approach some decisions by seeking out a predetermined rule or a standard operating procedure. In doing so, the process of seeking out information for situation awareness was not needed. Heuristics as a decision-making concept requires some explanation.

Judgmental heuristics is a concept that as decision makers build up experience or recognizable patterns, they use rules of thumb or shortcuts to reduce information processing demands (Simon, 1959). Simon has contributed to the theory that experience and recognition is a vital component to decision-making. He has coined the phrases, and later by expanded on by Tversky and Kahneman (1974), "availability heuristics"—a decision makers tendency to base decisions on information that is readily available in memory, and "representativeness heuristics"—a tendency to assess the likelihood of an event occurring based on impressions about similar occurrences (Tversky & Kahneman, 1974). Gigerenzer (1999) suggests that due to limited time and knowledge, cognitive biases do not have to get in the way of making decisions. By mastering simple heuristics, an approach he calls "fast and frugal" reasoning, decision makers can make use of their rational decision-making (Gigerenzer & Todd, 1999).

Using the pre-arranged category that emerged during the grounded theory research links to the heuristics findings mentioned above as a mitigation measure for avoiding decision-making paralysis. For example the emergency managers during

Hurricane Floyd used hurricane preplans on evacuating the at-risk population, the fire chiefs at the Word Trade Center used standard operating procedures (rules of thumb or judgmental heuristics) to decide who would be in command of the incident, and the fire chiefs at the Baltimore Tunnel Fire used a department manual to determine the line-of-succession to command the incident. In addition, during the two-week San Diego Firestorm, decision makers built up and used recognizable patterns (representativeness heuristics) as they made decisions on fire fighting operations.

The pre-arranged category emerged from the disaster cases as a finding that rules of thumb, or short cuts, can assist in reducing the information that needs to be processed when making a decision. This finding is grounded in the literature on heuristics theories and therefore the use of heuristics can be considered a decision-making mitigation measure.

C. STORY BUILDING

A mental model is defined by Thompson, Jamieson, Hendy (1997, pp. 971–976) as:

> The knowledge necessary to perform a task may encompass past, present, and future [task] parameters, goals, and considerations. Well-developed mental models are assumed to lead to more efficient information processing, to decreased time pressure and workload, and to better performance.

The descriptive study of mental recall or recognition-primed decisions conducted by researchers such as Klein on firefighters and soldiers (1998) brings to light that skilled decision makers will use the first course of action they identify, and that they often rely on a story-building strategy to simulate the situation when making a decision. In Klein's study, where time pressures, uncertainty, ill-defined goals, and other complexities were factors, the subjects were observed using the first decision option they considered without comparing the option to anything else.

Other scholars such as DeGroot (1965) on the game of chess and how moves are made based on visual memory and visual perception, Pennington and Hasite's "story

model" (1993) on how jurors build a casual explanation out of information to collaborate a story to make decisions, and Klein and Crandall (1995) on how decision makers mentally simulate what their decision is to see if it will work; also through story building. In the context of this thesis, their research provides information that decision makers in stressful situations will find a way to make a decision by story-building.

The disaster cases researched were catastrophic and, thereby, decision makers had little experience from the emergency or disasters they had responded to in the past to fall back on to make decisions. However, rather than using no recall at all, decision makers used what limited experience they could. The topic of story building can be linked to the category. Recognition which emerged from the grounded theory.

The link to the findings by decision-making scholars mentioned above and the findings that emerged from grounded theory are that decision makers in the catastrophic disaster cases, even when no mental recall was available, still managed to make decisions. This affirms the finding that in the absence of information and memory recall, decision-making can still take place by first making sense of the situation by gaining awareness through an iterative information gaining cycle of reading, visualizing, and or listening to the environment until the decision can be made. For instance, returning to the Baltimore Tunnel Fire where decision makers were dealing with a situation that had no parallels in their collective experience, they built a story of the situation by continually seeking out information. With no mental recall or recognition available, they built a story through sense-making by reading the way-bill of the train's content, observing the smoke from the tunnel, and listening to their hazardous materials team for their opinion on what could happen if their was an explosion. In summary, they made decisions based on existing conditions without comparing their options to anything else except from the information they were building upon from the environment.

Therefore, story-building as a strategy can be considered a mitigation measure for decision-making paralysis.

D. SENSE-MAKING

According to Drucker, "The effective decision maker always tests for signs that something is atypical or something unusual is happening" (1967, p. 94). A similar theory found in Drucker's statement emerged as a finding in the grounded theory research. For example, Drucker's statement linked to the research findings of sense-making, where decision makers were found to be making sense of the situation in order to make decisions, it becomes apparent that there exists a step of "testing" or checking the decision-making environment for "something happening." Testing for something happening in this context is a step in assessing or measuring the decision-making environment leading towards making a decision. In further examining other scholarly works, Klein's (1998) research on his RPD model accounts for a decision-making step which he calls sense-making. As noted in his writings on RPD, "it [RPD] fuses two processes: the way decision makers size up the situation to recognize which course of action makes sense, and the way they evaluate that course of action by imagining it" (Klein, 1998, p. 24). In combination with Drucker's and Klein's sense-making notions, and the finding from the grounded theory research, a theoretical framework is established that a step in making a decision, when situational awareness is low, high levels of uncertainty and equivocality exist, and there is an absence of recognition to make decisions, is to make sense of the situation by organizing what is known as a way of placing the situation into some form of order.

Reviewing additional scholarly articles written on the topic of sense-making and using the findings from the grounded theory research begins to build the foundation into how decision information can be categorized. To articulate the essential processes involved in sense-making, and bring the concept of organizing or categorizing a situation through sensemaking into perspective, requires turning to the studies of organizational theory.

Weick and Sutcliffe (2005), for example, have studied how people organize a situation by "labeling and categorizing issues to make sense of equivocal inputs and enact this sense back to make order of the situation" (2005, p 409). To expand on the finding

of sense-making further, recall from the literature review section that David Snowden has studied the act of sensemaking by developing a model called Cynefin (Snowden, 1999). Developed as a tool to categorize a situation, the Cynefin model illustrates the way a person can frame or places the situation and information into one of five areas of simple, complicated, complex, chaotic, or disorder (Snowden, 1999).

Linking what emerged from the research on the Pentagon disaster case illustrates that the fire chief as the decision maker was noted as continually obtaining situation awareness or making sense of the circumstance by seeing and hearing information to make decisions. In linking this finding to the scholarly research, the chief appeared to categorize and store the obtained information on the plane into the World Trade Center and the possibility of another plane headed to the Pentagon. There was no evidence from the catastrophic disaster case research that the decision-making stalled. The process of categorizing and storing the information enabled the chief to make a decision to evacuate the Pentagon. Therefore, the act of categorizing information and circumstances found in doing ground theory research is a process that has been observed by scholars on subjects as they label and categorize the situation to make sense.

E. STRESS AS A DECISION-MAKING FACTOR

The subject of stress became an overarching category throughout all the second order categories; specifically within the constraints, boundaries, and stress second order category. To affirm that stress is an influencer to the decision maker requires turning to the literature on stress; specifically findings on stress during disaster operations.

In a paper on the sources of stress to emergency managers, Paton and Flin (1999) state, "Stress adversely affects performance in circumstances that demand high levels of attention and creative solutions to emergency problems" (p. 262). In 2000, a study conducted by the Defense and Civil Institute of Environmental Medicine investigated the effectiveness of experiential cross-training in a team context for team decision-making under time stress in a simulated naval surveillance task (McCann, Baranski, Thompson, & Pigeau, 2000). The decision-making premise used in this study resembles that of what could transpire during a catastrophic disaster. For example, similar to military missions,

catastrophic disaster operations takes place in environments where uncertain information resides, there are time constraints, can involve high stakes, and must often be accomplished under conditions of mental fatigue and high workload. The number and magnitude of these constraints can undermine decision-making (McCan et al., p. 1095).

In doing further research on what could cause stress or influence decision-making, Zsambok and Klein have written in a book on naturalistic decision-making: "The identification of key contextual factors that affect the way real-world decision-making occurs, in contrast to their counterparts in the traditional decision research paradigm evolved as a major contribution of the 1989 NDM [Naturalistic Decision-making] conference (Orasanu & Connolly, 1993). They are:

- Ill-structured problems (not artificial, well-structured problems).
- Uncertain, dynamic environments (not static, simulated situations).
- Shifting, ill-defined, competing goals (not clear and stable goals).
- Action/feedback loops (no one-shot decisions).
- Time stress (as opposed to ample time for tasks).
- High stakes (not situations devoid of true consequences for the decision maker).
- Multiple players (as opposed to individual decision-making).
- Organizational goals and norms (as opposed to decision-making in a vacuum)" (Zsambok & Klein, 1997, p. 5).

Along with lack of experience and little knowledge in managing catastrophes, factors such as the above can contribute to paralyzing the decision-making process. As seen with the September 11 terrorist attacks, the nature of a catastrophic disaster creates chaos for both the communities impacted, but also the emergency managers who can become confused and disorganized (Drabek, 2003).

In reviewing literature on stress, it becomes apparent that stresses such as anxiety or fear are influences that an individual encounters that can affect their decision-making performance. As mentioned in a paper on stress in leadership, "Stress in the form of anxiety about the situation and fear in making a decision reduces the decision maker's performance; which results in a condition where decision-making becomes paralyzed"

(Kapucu & Van Wart, 2008). While it was not obvious that any of the decision makers in the catastrophic disaster cases feared making a decision, it can be speculated that because the decision makers were managing extraordinary levels of disruption, they could have been experiencing stress because of disagreements or difficulties in obtaining information to make decisions.

This was the situation at the Baltimore Tunnel Fire when fire chiefs had to search for information and the Mayor's Office did not agree on evacuation operations. Stress also emerged as a category from the Hurricane Floyd disaster case. Emergency managers were frustrated that the evacuation order could not be issued until a government executive order was issued. It should be noted that there were limited accounts of stress in the disaster cases; however, it is such an important topic to consider as a mitigation measure that it deserves further attention.

As remarked in the Hurricane Katrina Report, a disaster at this level contains situations at extraordinary levels that are wrought with stressors that can affect the emergency manager's decision-making abilities (HR, 2006). Even an emergency or routine disaster has shown to result in stress. For example, in a paper on stress responses of emergency services personnel to the Loma Prieta Earthquake (Marmar et al., 1996, p. 65), the authors site a study of stress to emergency responders. In this case, 79 rescue, fire, and medical personnel as well as police officers who responded to victims of an apartment building explosion were observed (Durham, McCammon, & Allison, 1985). "They reported a high prevalence of intrusive thoughts in those working with or searching for victims at the disaster site. In this study they concluded that "emergency workers responding to contained small-scale disasters are likely to experience milder stress symptoms" (Durham, McCammon, and Allison, 1985). In further linking stress to the research on catastrophic disasters, such as that conducted by Thomas Drabek (2003), he has concluded that these types of disasters (catastrophic) contain many stressors. Drabek notes that a catastrophic disaster will cause confusion and disorganization for the emergency manager at a level never before encountered. From Drabek's study on disasters (2003) and Paton and Flin's (1999) statement on the affects of stress, it is theorized that during a catastrophic disaster if our brain is allowed to process information

without any outside influences or distractions, the chances of making good decisions could increase. There are, however, arguments that stress is not a factor in decision-making; in fact it may be an asset.

In a paper on high stake decision-making (Kunreuther, Meyer, Zeckhauser, et al., 2002, p. 262), "A large number of empirical studies find that enhanced stress focuses decision makers on a selective set of cues when evaluating options (e.g., Kahn & Baron 1995; Ben Zur & Bernitz 1981; Kahn & Luce 2001) and leads them to make greater use of simplifying heuristics (e.g. Luce, Bettman, & Payne, 1997)." Gary Klein (1998, p. 275) claims "that stress does affect the way we process information, but it does not cause us to make bad decisions based on the information at hand." In other words, it is not the individual experiencing stress that causes ineffective decision-making; rather, it is disturbances or information intrusions that cause ineffective decision making.

Klein's case studies on first responders in stressful situations showed that "extreme time pressure, high stakes, and ambiguity" had no influence on decision-making (Klein, 1998, p. 275). As noted by Kowolski-Trakofler, and Vaught (2003, p.4) "for some individuals heightened stress elevates their performance. In addition, on the issue where experience is a factor in reducing stress, Paton and Flin (1999) noted that "emergency managers may have built up experience and have become resilient in managing emergencies or routine disasters" (p.264).

In summary, from the literature reviewed on stress and stress during a disaster, there are positions taken that stress influences the decision maker's performance (Kapucu & Van Wart, 2008), stress has no influences on the decision maker's performance (Klein, 1998), stress can assist the decision maker in focusing in on a decision (Kunreuther et al, 2002), and that stress elevates the use of intuition of the decision maker (Kowolski-Trakofler et al., 2003). In addition, the decision-making environment can influence the decision maker's abilities. The environment, because it is filled with uncertainties, can cause instability in gaining situation awareness; thus creating stress; however, stress, if minimized but not totally eliminated, could serve as an enhancer to decision-making. Meaning, if the decision maker's stress level is maintained at a perceptive level, decision-

making will not become paralyzed. Therefore, overlooking stress as an influencer would detract from building a catastrophic disaster descriptive decision process model.

F. CONCLUSION

By linking the decision-making findings that emerged from the grounded theory research to several decision-making scholarly sources, it is now realized that due stress, and a decision-making environment that may not hold all the information, there are limits to decision-making. Some decision makers were noted to overcome these limits by resorting to shortcuts, others were found to build a story in a sensemaking step. Regardless, decision makers will make a decision based on their abilities and what information is known at the time, not necessarily what is available or what the environment is capable of producing. It is therefore necessary to prompt the decision maker to enhance their abilities by seeking information from the environment so that a desired decision-making state is achieved where decisions are being made, not developing into a paralyzed state.

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VI. NEW PROCESS MODEL DEVELOPMENT

A. TURNING THE FINDINGS INTO A DESCRIPTIVE DECISION PROCESS MODEL

By linking the findings of the second order categories of assessment, comparative evaluation, constraints/limitations/stress, pre-arranged, predictive estimations, recognition, and sense-making from the grounded theory research to the decision-making literature, a descriptive decision process model has emerged that comprises the decision-making environment and involves the decision maker. The concept that emerged from the research findings is that when the decision-making environment has high levels of uncertainty and equivocality, and the decision maker's abilities and situational awareness are low, decision-making paralysis could occur. Decision-making paralysis is a condition where the decision maker is not making decisions on life safety and important emergency management operations. Therefore, mitigating decision-making paralysis resides in forming recognizable patterns through and iterative cycle of building ability and information from the decision-making environment. In other words, decision-making paralysis can be mitigated by building a story from the environment to enhance situation awareness, and as a result, improve decision-making abilities. A consideration in realizing this idea is that the decision maker, because of little or no catastrophic disaster experience, has minimal recall if any at all and that the decision-making environment contains the information needed for story building, which leads to decision-making.

To illustrate, Figure 1 depicts high levels of uncertainty and equivocality on the Y axis, and low abilities and situational awareness on the X axis. The space contained within the two lines represents the decision-making environment. The point at which the two lines over time approach each other, yet do not intersect, symbolizes decision-making paralysis. Figure 2, on the other hand, demonstrates the proposed idea in mitigating decision-making paralysis. In this diagram, the two lines are quickly narrowed and intersect representing the decision-making point. To get the lines to intersect and

thereby mitigating decision-making paralysis calls for using the environment to form recognizable patters through an iterative information and ability-building cycle.

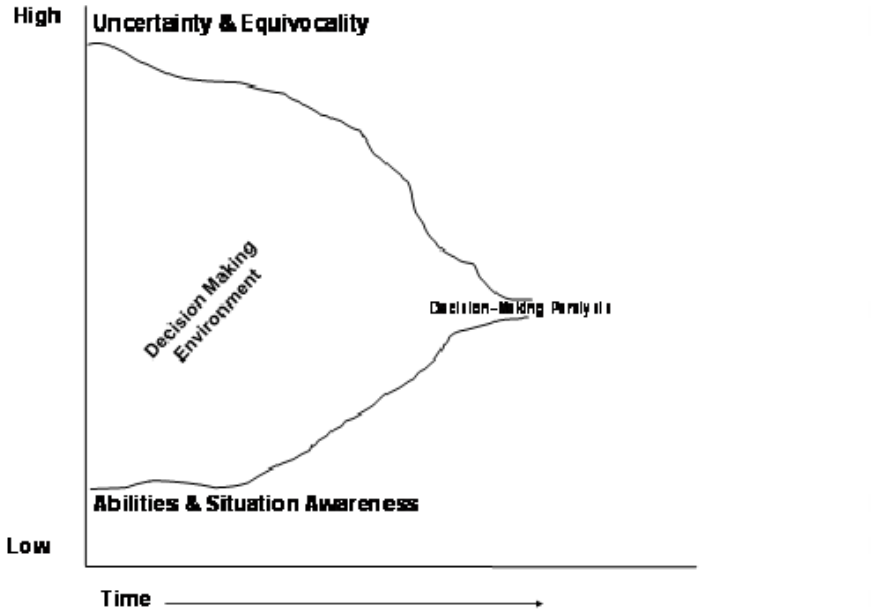

Figure 2. Decision-Making Paralysis

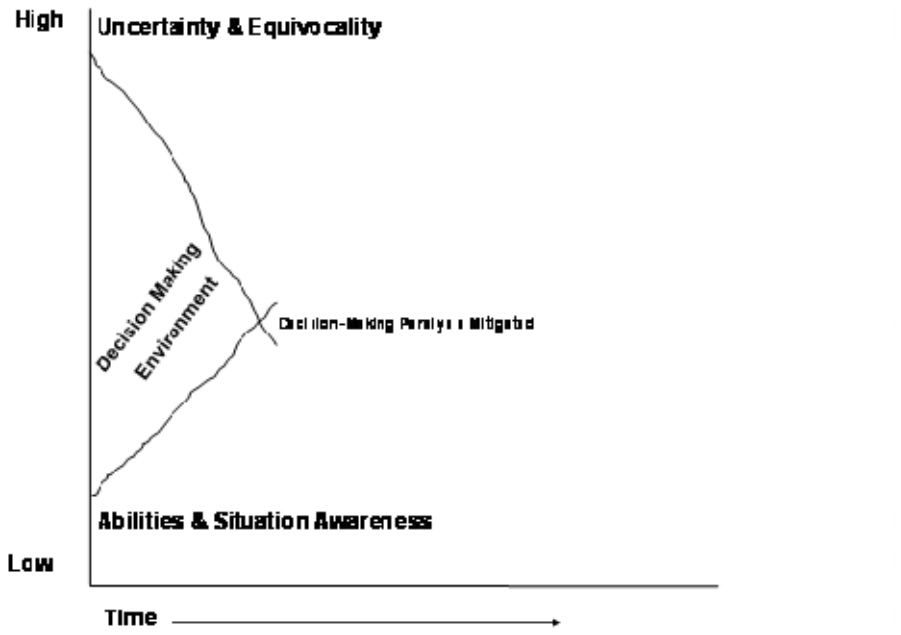

Figure 3. Decision-Making Paralysis Mitigated

B. FOUR DECISION PROCESS MODELS

As found during the grounded theory research and confirmed in the literature review, decision-making is a dynamic process of searching for past experiences and information to connect to the current situation. Or, if unable to drawn upon past experiences, "using a process of learning, understanding, information processing, assessing, and defining the problem and its circumstances can be used to make decisions" (Zeleny, 1982, p. 86). With this in mind, to mitigate decision-making paralysis and make decisions during a catastrophic disaster, emergency managers need a fast, flexible decision-making process; a process that involves a way to increase decision-making abilities. Rather, than designing a decision-making process model from the ground up, several researched and tested models and processes are sought out for relevance.

However, there are a number of decision theories available from the research fields of cognitive science, social science, decision science, and organization studies to choose from in developing the new process. These theories have been developed into

decision-making models and processes by researchers for specific purposes, such as public choice theory (Buchanan & Tullock, 1962) for political science applications in understanding how people vote, and game theory (Luce & Raiffi, 1957), which is a concept of studying rational behavior of individuals in situations involving struggle, outguessing, and bargaining (Simon, 1959, p. 266). Therefore, to select the most relevant models and theories so that a new process model can be developed necessitates resorting back to the second order categories of assessment, comparative evaluation, constraints/limitations/stress, pre-arranged, predictive estimations, recognition, and sense-making found during the grounded theory research. Although several existing decision models were reviewed, such as avoidance, adaptive, and decisive, they were not applicable to mitigating decision making paralysis; however, there are four models found to contain aspects of the second order categories. The four models are Drucker's business model, the military decision making model, the observe, orient, decide, act loop, and recognition-primed decision making.

To evaluate the selected models, the second order categories mentioned above, and the author's 9/11 decision-making experience are used to put each of the four models in action. Lastly, the new descriptive decision process model developed leveraging the four selected models is also put in action.

1. Drucker's Business Model

From the normative research conducted on business decisions, Drucker's business model (1967) is found to be a short prescriptive sequence of decision-making steps. In other words, this model suggests several short steps to follow in order to make decisions. The following are the steps in Drucker's model along with a brief explanation (in italics) provided by Drucker (1967):

1. The classification of the problem.
   Is it generic? Is it exceptional and unique? Or is it the first manifestation of a new genus for which a rule has yet to be developed?

2. The definition of the problem. What are we dealing with?

   The specifications which the answer to the problem must satisfy? What are the boundary conditions?

3. The decision as to what is "right" rather than what is acceptable, in order to meet the boundary conditions.

   What will fully satisfy the specifications before attention is given to the compromises, adaptations, and concessions, needed to make the decisions applicable?

4. The building into the decision of the action to carry it out.

   What does the action commitment have to be? Who has to know about it?

5. The feedback which tests the validity and effectiveness of the decision against the actual course of events.

   How is the decision being carried out? Are the assumptions on which it is based appropriate or obsolete? (Drucker, 1967, p. 92).

a. Evaluating Drucker's Business Model

Using the second order categories, Drucker's business model is evaluated to demonstrate relevance in mitigating decision-making paralysis.

Table 2. Drucker's Model Evaluated Against the Second Order Categories

Second Order Category	Evaluation
Assessment Separating a complex topic into smaller parts to gain a better understanding.	The short and easy to understand steps of the model enables the decision-maker to break down the decision topic into smaller parts as a way of gaining a better understanding of the decision.
Comparative Evaluation Continually measuring options against the current information.	Step 6 contains a "feedback" step which promotes evaluation of the decision, or the steps leading up to the decision, "against the actual course of events".
Constraints/Limitations/Stress Identifying limitations and constraints to actions.	Step 3 asks about the specifications that must be satisfied. This step helps bring out exactly what information needs to be considered as part of the decision and if that information creates boundaries in making the decision.
Pre-arranged Resorting to a set of predetermined rules or standards.	Step 1 is about classifying the problem. This particular step is useful in determining if there is an existing rule that can be referenced.
Predictive Estimations Forecasting, estimating, and hypothesizing.	Step 4 requires the decision maker to consider from the decision-making environment what will work. In other words, there is relevant and irrelevant information. This step prompts the decision maker to evaluate what the "right" information is to make the decision; rather than what is "acceptable". Step 5 is also assists by considering the actions being carried out by the decision. Forecasting, or thinking ahead, is a valuable decision-making step.
Recognition Remembering from past events or past practices, assimilating to the situation, historical reflection.	Although there may not be anything to recall on, Step 2 is an effective starting point in asking "what are we dealing with".
Sense-making Define the situation and making sense of the situation by describing, classifying visual, textual, and oral, information.	Combined, Step 1 and Step 2 prompt the decision maker to frame the situation as a way of making sense.

Using the decision of where emergency management vehicles would be safely staged at the WTC disaster to illustrate the second order categories and the concepts of Drucker's model, the steps are put into action.

Table 3. Drucker's Model Put into Action

Decision Step	Second Order Categories	Evaluation
1. The classification of the problem.	Assessment, Pre-Arranged, Sense-making	The decision as to where a staging location should be located is a general decision containing smaller decisions. By beginning the process with a step of classifying the problem, this step would have lead to separate decisions such as is the area large enough and is it accessible. This step would also assist in identifying if there are existing procedures or protocols for the location for emergency vehicles to stage, such as a parking lot or on a street. In fact there were standard operating procedures in place. This was a decision the author made many times before using the procedure and is considered a standard practice at any large-scale emergency or disaster. This classification step is also a step in making sense of the situation because it compels the decision maker to examine the decision-making environment for the needed information.
2. The definition of the problem.	Comparative Evaluation, Sense-making	Defining the problem would have revealed several essential factors in selecting a safe staging location such as a location that would be easily accessible and had ample space for the vehicles. The process of defining can also be considered a step which requires measuring options; such as comparing the advantages of using another staging location to the current location being selected. By evaluating and comparing the

		different staging locations, this step is also a contributing piece in making sense of the situation which leads to building a story from the environment.
3. The specifications which the answer to the problem must satisfy?	Constraints/Limitation/Stress, Predictive Estimations	This step would have framed the decision by asking if the staging area needed to have an access and egress route, large enough to hold all the vehicles, and close enough to the WTC area yet a safe distance away. By framing, this step helps in controlling the information the decision maker needs to obtain for the decision. This step also makes the decision maker consider the outcomes of the decision.
4. The decision as to what is "right" rather than what is acceptable, in order to meet the boundary conditions.	Constraints/Limitation/Stress	Selecting a safe staging location was a "wicked" problem. There were a limited number of locations that could be used. Using this particular step would have helped in recognizing that choosing one location could effect some other emergency management operation such as a command post location or a triage and treatment location. Not selecting the best suited or the right staging area would result in another decision at a later time to correct the first decision. This step prompts the decision-maker to search the decision-making environment for the correct information to make the decision.
5. The building into the decision of the action to carry it out.	Comparative Evaluation, Predictive Estimations	By measuring the commitment of the decision against information leading to the decision, this step would assist in determining the issues required to implement the decision. In other words, this step prompts the decision maker to consider what the effects of the

		decision will be. Using this step would have been helpful in raising the need to let the response vehicles drivers know where the staging location was to be established. This action would have stimulated the process of hypothesizing or thinking ahead the effectiveness of the staging location.
6. The feedback which tests the validity and effectiveness of the decision against the actual course of events. (Drucker, 1967, p. 92).	Comparative Evaluation	Because of the towers collapsing, the decision was never made therefore the decision never reached this point. However if the decision was made, the effectiveness would have been evaluated by how many of the first responders found the area to get to, utilized the staging area for their vehicles, and was large enough to hold the vehicles.

b. Drucker's Business Model Strengths and Weaknesses

In Step 4, "The decision as to what is 'right' rather than what is acceptable, in order to meet the boundary conditions" contains a very good and useful concept (Drucker, 1967, p. 96). Here, the decision-maker is prompted to consider what is right and what is wrong for the boundary conditions in making the decision (Drucker, 1967, p. 96) and only express what is right in making the decision. In other words, the decision-maker should not use irrelevant information and make a decision for the sake of just making a decision. The decision should be made based on what will provide the proper solution to the problem. This step also seems to link to Simon's "satisficing" finding that decision makers have a tendency to acquire manageable rather than optimal amounts of information (1959). The requirement in Step 4 solicits information that if it is not available, then the decision maker needs to obtain the information before advancing to the next step.

In general, this concept can be interpreted into terms that decision-making can be made with limited information; granted the information is within the scope of the

problem. Meaning the information gained needs to be linked to problem being solved. To illustrate, a decision on evacuation will have information on the number of evacuees and shelter capacity. The evacuation decision cannot be expected to have effective results if the information is obtained from something unrelated such as the decision on selecting a location for command post operations.

Because the concept of using relevant information to make the right decision has value, it is used in both the information building and sense-making cycle and the ability building cycle of the descriptive decision process model being proposed. For example, the information and ability is built upon by using the decision-making environment and using what is relevant from the decision maker's recognition or training related to past emergencies or disasters. The decision-maker can make the decision when a desired state is achieved; however, the information obtained and the ability built must come from within the decision-making environment and from within the decision maker's capabilities. Although this particular concept is useful, there are others that are not.

Drucker's step process may be of use to the business executive in a setting where time is not a factor and information, if not readily available, can be obtained. However, this process may not be entirely effective in a situation the thesis is addressing, which is decision-making paralysis during catastrophic disasters where wicked problems exist. For example, several of the catastrophic disaster cases studied and the decisions I made at the WTC centered on the life-safety of first responders and the public. As a result of any decision with life-safety at stake, time was of the essence. Decision makers using Drucker's suggested steps in a catastrophic disaster could find that their decision-making process becomes paralyzed and have negative results.

2. Military Decision Making Model: MDMP

In an opposing setting to the business environment, The *Army Planning and Orders Production Field Manual 5-0*, (Department of the Army, 2010) describes the decision-making model of the Army's military decision-making process (MDMP). MDMP (Figure 3) is a systematic process designed for military commanders in a "time-

constrained environment to organize their planning activities, share a common understanding of the mission and commander's intent, and develop effective plans and orders" (Department of the Army, 2010, p. 3-1). In viewing this model from a decision-making perspective rather than as a planning tool, MDMP is a ridged and succinct methodical process with each step having a definitive outcome before moving onto the next. Taken as a whole, MDMP illustrates how the process of memorizing a predetermined set of rules or standards for recall during a catastrophic disaster can be used to make decisions.

Using the second order categories, the MDMP is evaluated to demonstrate relevance in mitigating decision making paralysis.

Table 4. MDMP Evaluated Against the Second Order Categories

Second Order Category	Evaluation
Assessment Separating a complex topic into smaller parts to gain a better understanding.	There are separate yet connected steps in MDMP that assist the decision maker in dividing the decision into separate components. This enables the decision maker to understand the decision being made.
Comparative Evaluation Continually measuring options against the current information.	Step 5 is helpful in evaluating if the current COA is of use by comparing it to the current or other COA's.
Constraints/Limitations/Stress Identifying limitations and constraints to actions.	In Step 2, the decision maker goes through an analysis process of identifying what will limit or constrain the decision.
Pre-arranged Resorting to a set of predetermined rules or standards.	By developing COA in Step 3, the decision maker is building rules or standards.
Predictive Estimations Forecasting, estimating, and hypothesizing.	By going through an analysis process of the COA, Step 4 encourages forecasting what the effects of the COA could be.
Recognition Remembering from past events or past practices, assimilating to the situation, historical reflection.	Step 2 is a mission analysis step which appears to stimulate the decision maker into considering if there were any past situations that could be linked to the current decision.
Sense-making Define the situation and making sense of the situation by describing, classifying visual, textual, and oral, information.	The analysis component of Step 2 also contains a step to assist in making sense of the situation. This is found to be a comprehensive step that prompts the decision maker to scan the decision-making environment for relevant information.

a. Evaluating MDMP

Using the decision to evacuate personnel from the EOC to illustrate the second order categories and the concepts of the MDMP model, the steps are put into action.

Table 5. MDMP Put Into Action

Decision Step	Second Order Categories	Evaluation
1. Receipt of Mission	Assessment	This step would have helped in determining exactly the topic of the decision. In this case, should the OEM staff in the EOC be activated or not?
2. Mission Analysis	Assessment	By analyzing the mission, this step would be helpful to determine that evacuating the OEM staff required weighing the advantages against the disadvantages of losing the use of the EOC.
3. Course of action (COA) Development	Predictive Estimations	This step would clarify what would be needed to effectuate the evacuation process, who would be involved (both as evacuees and evacuation coordinators), and the duration of the evacuation to get everyone safely out.
4. COA Analysis	Comparative Evaluation	This analysis step becomes an overall asset in making the decision. It would have assisted in evaluating the effectiveness of the evacuation such as by assessing what was used and what was still needed to complete the evacuation, if all OEM staff were evacuated and if additional or less evacuation coordinators were required, and if the evacuation was proceeding at the expected time allotment.
5. COA Comparison	Comparative Evaluation	This step would have lead to evaluating if the COA implementation could be improved by using another COA.
6. COA Approval	Constraints/Limitations/Stress	Considering the decision to evacuate the EOC was a significant decision to emergency management operations, this step would have suggested that getting approval from senior OEM staff would be a prudent measure. *However, this step could limit the decision making.*
7. Orders Production (Department of the Army, 2010)	Constraints/Limitations/Stress	The step of developing a plan for the decision to evacuate the EOC in this circumstance was not needed. *However, this step could limit the decision making.*

b. Military Decision Making Model Strengths and Weaknesses

MDMP consists of a predetermined step-by-step approach in making a decision. This analytical process may appear tedious; however it can be viewed as an asset for mitigating decision-making paralysis. For example, by resorting to a process containing prompts such as receipt of mission, mission analysis, COA development, etc., the decision-maker is guided through a progression of steps leading to decision (Department of the Army, 2010, p. 3-43). The concept of stepping through a decision emerged from several of the disaster case studies as the second order category pre-arranged and was noted as to be resorting to a set of predetermined rules or standards. A strong point of MDMP that can be leveraged is that the model itself can be viewed as a set of predetermined rules or standards used in making a decision.

To illustrate, there was a set of predetermined rules or standard operating procedures (SOP) noted to have been used in the 9/11 EMS disaster case (McKinsey Company, 2002). The SOP was resorted to in making a decision on which ambulance units to respond to the WTC. Similar to MDMP, the EMS SOP is somewhat of a step through checklist. The decision maker did not need to consider where the ambulances would come from or how many would be needed. By simply following an SOP that in general asked the location of the incident, how many patients, and how many are critical, a story of the situation was being built. In addition, the advantage in following an analytical process such as this is that the decision maker is engaged in a cycle of repeatedly analyzing the environment in a way that the decision maker's ability begins to increase. The cycle of story building and ability building, therefore, informs the decision-making process as it advances to ensure the outcome will be correct, thus ultimately leading to decisions rather than no decisions at all.

MDMP is described as "a planning model that establishes procedures for analyzing a mission, developing, analyzing, and comparing courses of action against criteria of success and each other, selecting the optimum course of action, and producing a plan or order" (Department of the Army, 2010, p. 3-1). Although effective in cases where time is not an issue, when decisions must be made quickly however the analytical

process of MDMP is not optimal for use during a catastrophic disaster. Researchers have commented that "the time expended during sophisticated simulation, analysis, and comparison of the options increases as the number of potential courses of action increases" (Van Riper& Hoffman, 1998, pp. 7–8). For example, from the MDMP, taking time during a catastrophic disaster to analyze what the mission is will not provide any advantages, and comparing the concepts of how the decision will be put into operations and producing orders could potentially paralyze the decision-making process. As a result, when the solution to the decision is finally arrived at, it is obsolete. The solution to avoiding a time consuming process is to refine and limit what is being consider in the model.

3. Observe, Orient, Decide, Act Loop: OODA LOOP

In an analysis on how American fighter pilots made decisions while in the stressful environment of combat, U.S. Air Force Pilot John Boyd developed observe-orient-decide-act loop (Boyd, 1987). The OODA loop (Figure 4) is a model that describes a thought process used in the deciding and acting stages of decision-making. The activities in the model consist of observing the environment, orienting oneself for the next stage of deciding what to do next, and ending with an act which involves implementing the decision. Based on what emerged during the grounded theory research, OODA loop contains the second order category of sense-making in the observe and orient stages.

Figure 4. Observe, Orient, Decide, Act Loop (From Boyd, 1987)

Using the second order categories, the OODA loop is evaluated to demonstrate relevance in mitigating decision making paralysis.

Table 6. OODA Loop Evaluated Against the Second Order Categories

Second Order Category	Evaluation
Assessment Separating a complex topic into smaller parts to gain a better understanding.	OODA loop was selected as a model because like Drucker's business steps and the steps in MDMP, it allows the decision maker to separate the decision into smaller parts in order to gain an understanding.
Comparative Evaluation Continually measuring options against the current information.	The step of orienting is an activity that leads to evaluating and measuring what is known against the decision-making environment.
Constraints/Limitations/Stress Identifying limitations and constraints to actions.	In the observing step the decision maker has the opportunity to identify any limits or constraints in making the decision.
Pre-arranged Resorting to a set of predetermined rules or standards.	Although there is no definitive step that calls for resorting to predetermined rules that step of orient can be used to ascertain whether there are pre-arranged protocols that can be used in making the decision.
Predictive Estimations Forecasting, estimating, and hypothesizing.	The decide step is where the decision maker can initiate what the decision outcomes could be.
Recognition Remembering from past events or past practices, assimilating to the situation, historical reflection.	The orient step is a step that the decision maker can use to recall on past events.
Sense-making Define the situation and making sense of the situation by describing, classifying visual, textual, and oral, information.	The observe step is where the decision maker can scan the decision-making environment for information to enhance situation awareness for sense-making.

a. Evaluating OODA Loop

Using the decision to move the EMS crews setting up a triage and transportation operation in an area where there was falling debris to illustrate the second order categories and the concepts of OODA loop, the steps are put into action.

Table 7. Putting OODA Loop Into Action

Decision Step	Second Order Categories	Evaluation
1. Observe	Assessment/Sense-making	By engaging in the observation step, the EMS crews would have been noticed working in an area that became quickly dangerous because of falling debris from the towers. The observation step is important in understanding what is occurring in the environment. In this particular situation, the environment would have been separated into smaller parts by accessing where the EMS crew was positioned, where the debris was falling, and where an alternative safe place would be.
2. Orient	Sense-making	By becoming oriented with the decision-making environment, it would have become evident that because of the falling debris, allowing an EMS crew to set up the triage and treatment area anywhere in the vicinity of the towers was not an efficient decision.
3. Decide	Comparative Evaluation	Although an obvious step, the simple step of Decide prompts the decision maker to consider implementing the decision against not making a decision. In this case, Decide was a step that included instructing the EMS crew to move to another location.
4. Act	Predictive Estimations	The act step is where the decision is thought about, where options are weighed prior to implementing; which in this case resulted in the EMS crews moving to another location.2

[2] The author was recognized as an EMS Lieutenant by the EMS crews who immediately complied with the instructions to move.

b. Observe, Orient, Decide, Act LOOP Strengths and Weaknesses

The concept of carrying out a loop or a cycle, such as found in OODA loop is an aspect found to be a beneficial process which the other models also contained. In addition, there is something to be gained from a model that only has four phases of observe, orient, decide, and act; such that it is simple to memorize and quick to put into action. To explain, the short iterative loop concept of Boyd's OODA loop simplifies the decision-making process to a point where there are no lengthy or difficult questions to decipher through. Additionally, because the OODA loop is an uncomplicated model, "testing or checking the environment" (Drucker 1967, p. 94) for something happening is expedited. Therefore, the second order category of sense-making has the potential to be achieved in a much more efficient manner.

However, the simplified phases of OODA loop has some shortcomings. As pointed out by Lawson (1981), OODA loop does not take into account a terminal point or a "desired state" at which to exit the loop (p. 6). By stepping through OODA loop as illustrated by using the 9/11 experience in the previous section, it is difficult to determine if the act phase is the point where the decision maker can end the process and make a decision. Along the same principle of not having a point by which to consider a decisions status, there does not appear to be a step of checking for feedback to ensure the decision is on the correct track. There is also an absence of a description of what it is that is to be achieved in each of the phases. In addition, because one can only react to what one observes, if not observing the proper environment, the ensuing phase of orient, decide and act could end up being incorrect.

4. Recognition-Primed Decision Model: RPD

RPD (Figure 5) emphasizes that experience is used to make decisions and that there is no need to compare options when making a decision (Klein, 1998). RPD theory provides that the decision maker basis their decision on something that is recognized rather than following an analytical process such as found in MDMP step process. In

other words, the decision makers finds something as close a possible that they have experienced in the past relative to the current situation to make the decision rather than turning to a step process (Klein, 1998).

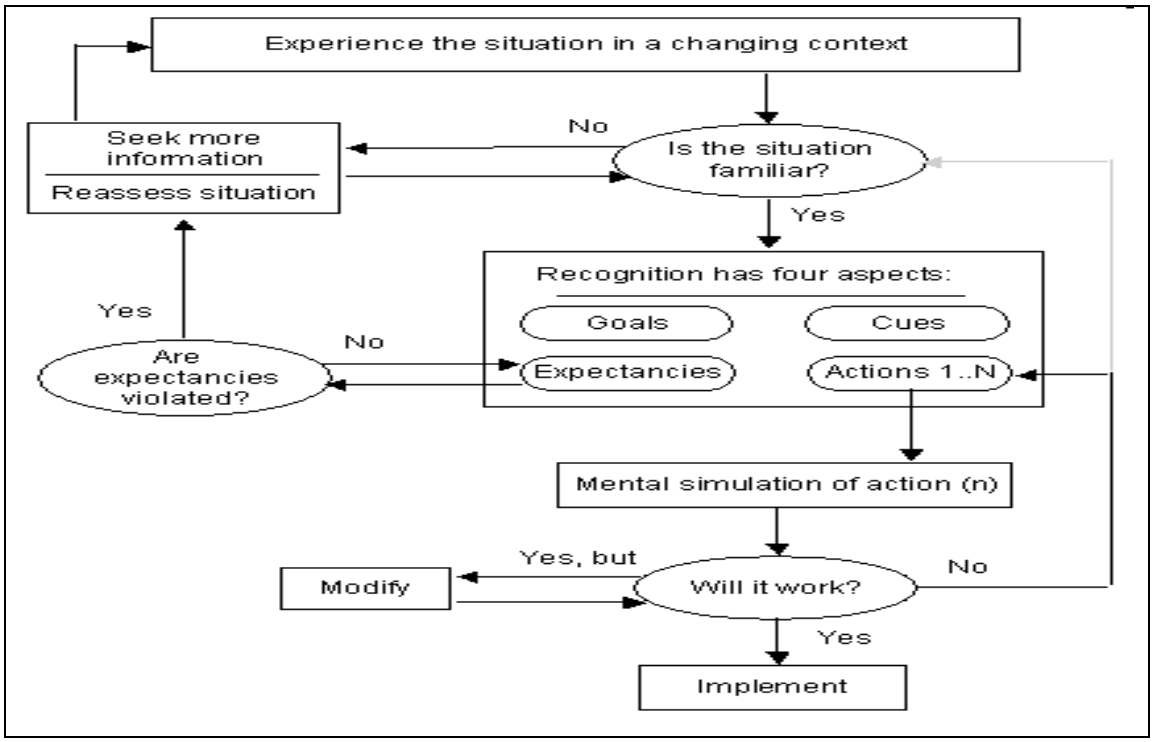

Figure 5. Recognition-Primed Decision (RPD) Model (After Klein, Orasanu, Calderwood, & Zsambok, 1995, p. 108)

Using the second order categories, the RPD is evaluated to demonstrate relevance in mitigating decision making paralysis.

Table 8. RPD Evaluated Against the Second Order Categories

Second Order Category	Evaluation
Assessment Separating a complex topic into smaller parts to gain a better understanding.	RPD has a unique step that prompts the decision maker to "seek more information/reassess situation" if the situation is not familiar. This section of the process encourages the decision maker to continually break down the situation until it is understood so that a decision can be made.
Comparative Evaluation Continually measuring options against the current information.	The initial section of "experience the situation in a changing context, seek more information/reassess situation" is where the decision maker continually evaluates the available information which can lead measuring what decision options are available.
Constraints/Limitations/Stress Identifying limitations and constraints to actions.	In the "are expectancies violated" section, the decision maker is asked to if expectancies, one of the four recognition aspects, are inhibiting the process. This is a valuable section because it suggests to the decision maker that there may be a limitation in moving forward with the decision. If there is, it warrants returning to the recognition section until the aspect is satisfied. In other words, if the decision maker is not able to reach the terms of what would satisfy the decision, there is something such as a lack in information in the way.
Pre-arranged Resorting to a set of predetermined rules or standards.	The "Recognition has four aspects" section is useful in that it prompts the decision maker to seek out if there are any "Cues" or "Expectancies" that would assist in the process.
Predictive Estimations Forecasting, estimating, and hypothesizing.	The "Will it work" section has a helpful concept that gets the decision maker to consider if the decision being contemplated will work. To satisfy this question, the decision maker is to either "Implement" or if the decision will not work, to "Modify."
Recognition Remembering from past events or past practices, assimilating to the situation, historical reflection.	The theory of RPD is based on recognition and the beginning sections of the model require some form of recognition.
Sense-making Define the situation and making sense of the situation by describing, classifying visual, textual, and oral, information.	"Experience the situation in a changing context," and "Seek more information/Reassess situation" is a significant section in the process which prompts the decision maker to continually make sense of the situation until it is familiar.

a. Evaluating RPD

Using the decision to remain at street level while the event was unfolding or return back into the EOC to illustrate the second order categories and the concepts of the RPD model, the steps are put into action.

Table 9. RPD Put into Action

Decision Step	Second Order Categories	Evaluation
Experience the situation in a changing context	Assessment	The situation at the WTC was dynamic and unfolded quickly. It became important to keep up with the situation. This step helps to keep the decision maker engaged by experiencing the situation as it changes.
Is the situation familiar?	Sense-making	Although in general the situation at the WTC was not familiar for making decisions, answering no to this question prompts the decision-maker to continually "seek more information" to make sense of what is occurring.
Seek more information/Reassess situation	Sense-making	Again, the process of continually engaging in a sense-making process is a valuable step towards making a decision. Using this step in the decision to remain at street level or return into the EOC, could have produced an efficient decision whereby the decision could have been arrived at more readily.
Recognition has four aspects: Goals, Cues, Expectancies, Actions 1…N	Recognition	This step focuses on recognition. Specifically, by using the four aspects the decision in this case would have considered if there were any past situations that could be recalled on to help make the decision.
Will it work?	Predictive Estimations	Using the steps of "Will it

Implement		work" and "Implement" would have prompted options to consider whether it was best to remain at street level or return to the EOC. Based on weighing the options the decision would be made in a timely manner.
Modify	Comparative Evaluation	Because the situation at the WTC was so dynamic and quickly changing, having an option in the process to modify the decision prior to being implemented is a very efficient step. This step enables the decision to be mentally compared to other possible decisions prior to implementation.

b. Recognition-Primed Decision Model Strengths and Weaknesses

The first step in the RPD model describes what Klein observed his study subjects (firefighters and soldiers) doing as they entered the decision-making environment to make a decision (1995). This initial step can be summarized as the decision maker experiencing and assessing the situation (environment), and if not satisfied, obtaining more information if needed. This particular step focuses on the decision maker and the environment of the decision-maker that is a simple concept, yet a strong point found in RPD. As a side note, this concept links back to the scissor analogy used by Simon (1990) where one side of the scissor is the cognitive abilities of the decision maker and the other side of the scissors is the structure the environment. In summary, a strong point of RPD is that it takes into account the decision maker and the environment of the decision maker. The added strengths of RPD is that it uses simple terminology such as "is the situation familiar, and will it work" (Klein et al., 1995, p. 108) and the decision maker has options such as yes and no as a way to return to a step if a condition is not met. By using yes and no options the model has an uninterrupted flow until the decision is reached and implemented; however, there are weaknesses to RPD.

Perhaps because RPD is based on observations of experienced decision makers while in their relevant settings, as a result they have the decision-making ability and the ability to recall on a past experiences to make the decisions, the model appears to satisfy decision making in general. However, when applied to decision-making during a catastrophic disaster, the RPD model contains a weak element. To illustrate, since it has been established in the Introduction section of this thesis, a catastrophic disaster is an incident that is significantly different than emergencies or routine disasters and contain problems never before experienced by the emergency manager. How then can the decision maker recall on something when they have never had the experience? RPD does not take into account a decision maker that has no recall or lacks the ability to make a decision.

5. Catastrophic Disaster Decision-Making Model: CAT D² M²

During the exploration of the most relevant decision-making models applicable to a situation where awareness is low and high levels of uncertainty and equivocality exist, it became apparent that the explored models and processes contained specific concepts that when leveraged generate the development of a new model to mitigate decision-making paralysis. By eliminating the weakness and using the strengths of Drucker's business model, MDMP, OODA loop, and RPD, a new process model was developed.

This new model, CAT D² M², states in conceptual theory that decision-making paralysis can be mitigated by first making sense of the situation in gaining awareness through an iterative story building cycle of data referencing, visual sensing, and or listening for sufficient rather than suitable information followed by, if needed, a cycle of recalling on training and experience, use of heuristics, and story building until the decision maker reaches a desired state to make decisions.

Achieving the desired state is a subjective variable dependent on the decision maker's urgency in making the decision. To describe, when lives are at stake, a decision to preserve lives could be contingent on limitations such as the decision maker's abilities and information at the time. However, reaching the desired state depends on the decision

maker's minimum requirements for information or "satisficing" to make the decision (March, 1994; Simon, 1959). The next section goes into details of the CAT D² M² process model.

C. CAT D²M² STEPS AND DISCUSSION

CAT D²M² (Figure 6) is a theoretical process model that takes into account the decision-making environment and the decision maker's ability when situational awareness is low, high levels of uncertainty and equivocality exist, and there is an absence of recognition to make decisions. This new process model considers a number of decision-making concepts from Drucker's business model, MDMP and OODA loop, and RPD in combination with the emerged findings from the grounded theory research. Specifically, like Drucker's steps and MDMP, CAT D²M² is a pre-arranged process containing the second order categories of assessment, comparative evaluation, constraints/limitations/stress, pre-arranged, predictive estimations, recognition, and sense-making. Meaning it is a logical step-by-step approach that can be memorized to make decisions; or to mitigate decision-making paralysis. There are three essential steps or questions contained in CAT D²M²:

1. STEP A: Is There Sufficient Information, Situation Awareness, and Ability to Make the Decision?

The objective of this step is to prompt the decision maker into considering if there is not enough ability, information, or situation awareness to make decisions; it must be obtained. If the answer is no, next is to go to step B. However, if the answer is yes to the question, the process does not prohibit making the decision. The decision maker can proceed to Step D and make the decision.

2. STEP B: Can the Environment Provide Information to Enhance Situation Awareness to Make the Decision?

If the answer in Step B is yes, next is to proceed to Step C. If the answer is no to Step B, the decision maker is prompted to seek out information from the environment by referencing data, hearing information, and or by visual sensing. It is important to

recognize that Step B in general represents the decision-making environment where there is information that can be used for story building. The reason for developing a step that seeks out data such as a printed material containing facts, listening to others for their opinions on the situation, and actually scanning the environment looking for signs or indications, is to increase the decision-makers situation awareness. By gathering and comparing information discovered in this step, the expectation is that sense-making will be enhanced; thus leading to making a decision.

To elaborate, the purpose of this step is to mitigate decision-making paralysis by enhancing the sense-making of the decision maker. The process of going around-and-around by checking the environment for information to enhance sense-making keeps the decision-maker engaged in the decision. Otherwise, the decision-maker's attention may become distracted or overwhelmed as I did at the WTC disaster on the decision to evacuate the EOC. Conversely, the fire chiefs at the Baltimore Tunnel Fire remained engaged with their decisions by continually turning to the environment for information and cross referencing or comparing what they were finding during their evacuation decision.

By keeping the decision maker occupied with in a comparative activity of referencing, hearing, and visualizing, the decision-maker remains connected to the environment until a point is reached where they feel they have enough information, or they are satisfied with the information (Simon, 1959) to make a decision. In addition to a cycle of using the environment for information, this step also contains the second order category assessment. Recall, assessment from the research is described as linking by comparison one piece of information to another. For example, this step is to link and compare textual data to perhaps what was heard in order to keep the decision-making process from becoming parlayed.

To recap, the intent of Step B is to engage the decision maker in an iterative cycle of gathering and comparing information until the decision maker reaches a desired information and situation awareness state. Once this desired state is achieved, the next Step, C, asks about the ability of the decision maker.

3. STEP C: Does the Decision Maker Have the Ability to Make the Decision?

If the decision maker has the ability to make the decision, meaning they have experience or can resort to a protocol or plan, then the next step is D: Decision; however, if there is no ability, the decision maker is prompted in Step C to engage in a cycle.

To illustrate, this particular cycle is similar to the OODA loop. It is designed to keep the decision maker engaged in the decision making process to increase decision-making abilities. The process includes recalling on training and experience, use what was gained in Step B through story building, and or use a rule of thumb (heuristics). The notion is that the story building gained from the decision-making environment in Step B, in combination of recalling on some experience, even if it is from a past community emergency or disaster, can build the ability of the decision-maker to make the decision.

This step also brings in the second order category assessment. Similar in the previous step, the decision maker continually links and compares what was gained from recalling on training and experience, from story building, and from the use of rule of thumb to build upon the decision-making ability. The goal in including a step such is this is to develop ability where it may be absent. In other words, rather than becoming paralyzed in making a decision because of a lack in ability, by continually searching for something to stimulate the process such as recalling on a remotely similar situation or a protocol that can be somewhat related to the situation is better than nothing at all, which from first-hand experience is where decision-making paralysis occurs.

There is an important component contained in Steps B and C that are missing in OODA loop and RPD. This component is a way out of the iterative cycle. For example, once a desired situation awareness and information state is achieved in Step B, there is a way to get out of the loop by going to Step C. Similarly, Step C has an exit out of the cycle. When the decision maker reaches the desired ability state, Step D, making the decision can be fulfilled.

In summary, by examining Drucker's steps, MDMP, OODA loop, RPD, and the CAT D^2M^2 models, through my decision-making experience at the WTC, a pattern is

now evident. A pattern which engages the decision maker in a cycle to establish that decision information and abilities are to be attained prior to "carrying out" (Drucker, 1967), "producing orders" (MDMP, 2010), "acting" (Boyd, 1987) "implementing" (Klein, 1999) and "reaching a desired state" (CAT D²M²). That through a process of sensemaking, recognition, and pre-arranged steps, decision-making paralysis can be mitigated.

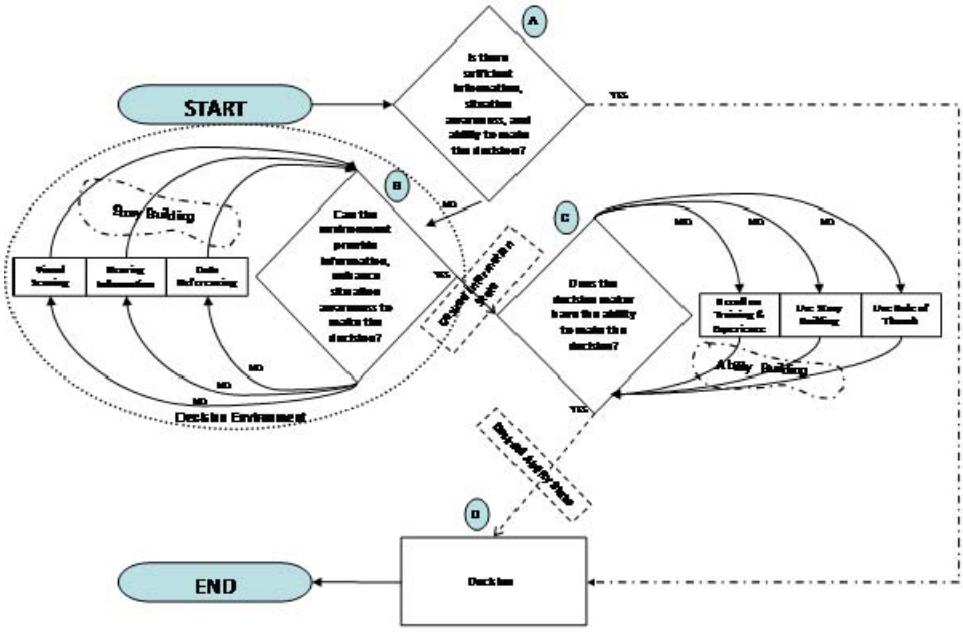

Figure 6. Catastrophic Disaster Decision-Making Model: CAT D²M²

D. EVALUATING CAT D²M²

Using the decision to evacuate lower Manhattan to illustrate the second order categories and the concepts of the MDMP model, the steps are put into action. [3]

Table 10. CAT D²M² Evaluated Against the Second Order Categories

Decision Step	Second Order Categories	Evaluation
A. Is there sufficient information, situation awareness, and ability to make the decision?	Assessment, Recognition, Sense-making	Step A is a fundamental step that either leads to ending or beginning the process model. Using this step on the evacuation decision, at the time the issue was raised to evacuate lower Manhattan there was little information on the status of the roadways and bridges out of Manhattan. In addition, situation awareness was low because the event was dynamic and unfolding at a level never before experienced, and the ability to make the decision was low because decisions like this were beyond the scope of what the author had made decisions on before. Not being able to answer these questions, the next step is to turn to the decision-making environment for data referencing, listening for information, and visualizing the environment.
B. Can the environment provide information to enhance situation awareness to make the decision?	Sense-making, Comparative Evaluation, Constraints/Limitations/Stress	Initially, the environment was not able to provide the needed information. In this case, the CAT D²M² iterative cycle would begin and continue to build a story until a desired state of information and situation awareness was

[3] Prior to making the decision to evacuate lower Manhattan, the North Tower collapsed followed by the South Tower a short time later. As a result, all emergency management operations temporarily ceased for obvious reasons.

Decision Step	Second Order Categories	Evaluation
		achieved. For example, there was limited information being reported over the two-way portable radios on the traffic conditions hampering the incoming fire and police units. Carefully listening to these reports provided some information such as the Brooklyn and Manhattan bridges were being used by people to self-evacuate on foot, the Battery Tunnel was at a gridlock, and the FDR Drive was congested with north-bound traffic. This iterative cycle continues until enough information is gathered to raise situation awareness to either make the decision, or at this point the ability of the decision-maker is questioned.
C. Does the decision maker have the ability to make the decision?	Recognition, Pre-arranged	Having never been confronted with a decision to evacuate such a large area in such short notice under stressful conditions, the author's ability to make a decision of this magnitude was low. In this situation, using CAT D^2M^2 the decision maker would have been prompted to enter into an iterative cycle of ability building. This involves recalling on training and experience, using the story building from the previous step, and using a rule of thumb. For example, the author would have recalled on experience from past flooding events where small portions of a community had to be evacuated, used a rule of thumb when considering an

Decision Step	Second Order Categories	Evaluation
		evacuation of: how many will go, where will they go, how will they get there? The other option would be to reference the story built in the previous step. Once a desired state of ability is achieved in this step, the decision-maker can proceed to the final step of making the decision and ending the CAT D²M² process.
D. Decision	Predictive Estimations	In this step the decision maker simply makes the decision which ends the process. However, prior to making the decision, the decision maker is prompted to build their ability and build a story from the environment. During the ability and story building process, there is a constant cycle contained in-between Steps B and C of reaching a "desired state". This process requires some speculation or forecasting of the decision. *Because of the Towers collapsing, the decision to evacuate lower Manhattan was never brought to fruition.*

E. CATASTROPHIC DISASTER DECISION-MAKING MODEL STRENGTH AND WEAKNESSES

Because CAT D²M² takes into account the decision-making environment and the decision maker's ability when situational awareness is low, high levels of uncertainty and equivocality exist; it is prescriptively adequate for a catastrophic disaster. The process model was developed by discarding the weakness of the models reviewed and leveraging their strengths. Because CAT D²M² has taken notice of the strong point of other models, it contains easy to understand terms, it has a flow that is flexible and simple to follow, it

takes into consideration an exit point, and most importantly it incorporates the decision-maker and the decision making environment into the process. To elaborate, CAT D²M² was developed by conducting research on catastrophic disaster cases, using theories from the study area of decision making, and leveraging existing decision-making models. By following this course of action only the most relevant decision-making findings were applied to the development of CAT D²M².

CAT D²M² is a prescriptive process that contains several unique steps. For example, there is a start point where the decision maker can enter the process and an end point to exit. A distinct step leveraged from the researched models is of the cycles that are contained in the story-building and ability building areas of the model. Here the decision maker is engaged in a cycle to increase situational awareness and sense-making as well as enhance the ability of the decision maker. It is not just a cycle of linking one step to the other, the cycle points the decision maker to the decision-making environment for data referencing, hearing information and visual sensing. In addition, the decision maker is directed to recall on training and experience, use story building from the previous step, and use rules of thumb to build upon the decision-making ability.

There are no constraining points contained in the model. A distinctive step in the cycle process of CAT D²M² is that there are exit points when the decision maker reaches a desired state. This allows the decision maker to proceed to the final decision-making as quickly as desired; even if that means having to skip a step because it is not needed.

Finally, CAT D²M² is developed by taking a neutral position on the decision-making environment and the ability of the decision maker. Meaning, it could be an environment rich with information and the ability of the decision maker may be excellent, or it could be the opposite. Either way, the model can be still used.

However, there are weaknesses. Not weakness to the model itself, weakness in that CAT D²M² was developed based on research, not on actual observations. Therefore it is unsure where the weaknesses are in the process. The true weakness will not become realized until the model is used and evaluated in an actual catastrophic disaster.

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VII. ANSWERING THE RESEARCH QUESTION AND EVALUATION OF CAT D²M²

This thesis began by asking if a new decision-making model could be developed for use during catastrophic disasters. Specifically, the question asked how can a new model be designed leveraging existing decision-making models to mitigate decision-making paralysis during catastrophic disasters when experience and situational awareness of the decision maker is low and the disaster environment has high levels of uncertainty and equivocality? Although there was no single decision-making model found to be capable of mitigating decision-making paralysis, the existing models researched did contain concepts that when leveraged lead to the development of CAT D²M². Therefore, the answer to the research question is yes.

To evaluate CAT D²M², or formally ground the concept of a descriptive decision process model, Glauser and Strauss suggest that the research is to be "accurate in fit and relevance to the area it purports to explain" (1967, p. 224). Meaning that the findings and theories that have lead to developing a new decision-making process model are truthful to the catastrophic disaster cases researched, the literature reviewed, and is germane in answering the research question. To ensure that CAT D²M² is accurate in fit and relevance calls for evaluating the process by asking first if it:

> …closely fits the substantive area in which it will be used, second is readily understandable by laymen concerned with this area, third it is sufficiently general to be applicable to a multitude of diverse daily situations within the substantive area, and fourth it must allow the user partial control over the structure and process of daily situations as they change through time. (Glauser & Strauss, 1967, p. 237)

The following outlines how CAT D²M²is evaluated against Glauser and Strauss' criteria (1967):

- Closely fits the substantive area in which it will be used - Because the concept of CAT D²M² is based on grounded theory research on catastrophic disaster cases, and scholarly decision-making theories and process, it fits well into the area of decision-making; specifically decision-

making during a catastrophic disaster. CAT D^2M^2 is a practical mitigation solution to assist when decision-making becomes paralyzed.

- Readily understandable by laymen concerned with this area - CAT D^2M^2 is easy for the emergency manager as a decision maker to understand and use. There is no technical jargon to learn, it follows a logical progression for making a decision, and because it is easily understandable and flexible, can become quickly committed to memory.
- Sufficiently general to be applicable to a multitude of diverse daily situations within the substantive area - CAT D^2M^2 is adaptable to any type of catastrophic disaster such as a hurricane or a terrorist event. It can also be used during an emergency or routine disaster. In addition, the process can be applied to any decision-making situation when situational awareness is low, high levels of uncertainty and equivocality exist, and there is an absence of recognition to make decisions.
- Allows the user partial control over the structure and process of daily situations as they change through time - The decision maker using CAT D^2M^2 is in control of the process flow and information used to make the decisions. There are no binding conditions to satisfy causing the process to stall, and there are no limitations to how often the iterative cycles can be used to make a decision. It is entirely up to the user to decide which step to proceed to, to make the determination when a desired state is reached, and when to exit the cycles.

A final measure is that CAT D^2M^2 provides a foundation for future catastrophic disaster decision-making research. One way to determine this is to have the new model reviewed and commented on by emergency managers and decision-making scholars. It is anticipated that the idea of using the environment to build situation awareness and decision-making abilities, and that the elements that constitute the iterative cycle are evaluated for their effectiveness in mitigating decision-making paralysis. An added value is if CAT D^2M^2 is applied to an actual incident. If CAT D^2M^2 is evaluated and commented on by emergency managers and decision-making scholars, it has proven capable of rising to a level of attention and, thereby, deemed as a contribution to the research on decision-making.

A. CONCLUSION

CAT D^2M^2 is a prescriptive process model based on conducting grounded theory research and an extensive literature review. The concept leading up to the development of the descriptive decision process model resulted in using an inductive method rather than a deductive method; however, it could benefit greatly from being tested and evaluated in an actual setting such as a disaster. Because CAT D^2M^2 was developed by using an inductive method leveraging existing decision-making models it is a practical solution in mitigating decision-making paralysis.

CAT D^2M^2 appears to succeed from one researcher's perspective used in this thesis, which is to make a judgment call based on past experiences and hope it satisfies the need (Klein, 1998). Therefore, the delivery of CAT D^2M^2 to interested parties, such as emergency managers and decision-making researchers, needs to illustrate that judgment calls are inefficient and the idea of engaging in an iterative cycle could be a solution to mitigating decision-making paralysis.

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APPENDIX. SECOND ORDER CATEGORIES

Table 11. Baltimore Tunnel Fire of 2001

Informant's Codes	Analytical Codes	Second Order Categories
A situation that had no parallels in their collective experience	**Recall** They were <u>not</u> able to **remember a past event** or past practice that they could use to **assimilate to the situation**. This was a contributing factor in the decision to evacuate.	Recognition
They realized the smoke was not dissipating at all	**Diagnose** Concerned with a BLEVE, and the decision to allow firefighters to work in the tunnel, they were able to **define** and **make sense of the situation** by visualization.	Sense-making
The smoke, it now dawned on them, was a result of a fire, not diesel fumes…	**Comparing/Recall** A contributing component to the overall decision-making that would be forthcoming. Here a **comparison** of a current visualization against what the FF **had experienced** in the past allowed them to **begin measuring options**.	Comparative Evaluation Recognition Assessment Predictive Estimations
When they reviewed the way-bill	**Targeting** Because they were in information deprivation, the FF **sought out specific information** for analysis to help them make decisions.	Pre-arranged
They realized with this information	**Diagnose** With the way-bill in hand, they were able to begin **defining the situation** and **make sense of the situation** via textual information.	Sense-making Assessment

Informant's Codes	Analytical Codes	Second Order Categories
Receiving reports from the public	**Diagnose** There was **specific information about the situation** coming in from the public that needed to be deciphered. The situation was made sense of via descriptions of oral information which contributed to how decisions would be made.	Sense-making
Observed a huge plume of smoke	**Diagnose** **Seeing** a plume of smoke, and **recognizing this was not good**, provided visual information to make decisions on what to do next.	Sense-making Recognition
Used to responding to structure fires	**Recall** A statement on **what is routinely conducted** and how that **experience was not helpful** in this situation. The FF **could not assimilate to the current situation**.	Recognition
So its like a routine call	**Recall** **Remembering from past events** or past practices, assimilating to the situation, historical reflection	Recognition
Reports from the public were supplemented	**Diagnose** Define the situation and making sense of the situation by receiving oral information	Sense-making
Getting a lot of information very quickly at that point	**Diagnose** A contributing DM point in **getting information** from CSX and the public. Making sense of the situation via oral information.	Sense-making

Informant's Codes	Analytical Codes	Second Order Categories
No one was quite sure what these chemicals would do	**Comparing** There was **no recall** from a past situation, which lead to no comparison or an analysis to predict what to do. No assessment of the current information, measuring options against the current information, forecasting, predicting, estimating, hypothesizing	Recognition Comparative Evaluation Assessment Predictive estimations
I think we all knew that there was a potential for something really serious with the hazmat component	**Recall** Based on **past experience and training**, the FF were able to use that to make a decision that there was a high risk of sending FF into the tunnel.	Recognition
It has wiped out small towns	**Recall** They **knew from training** that a BLEVE was a dangerous situation and decisions should were based on knowing that	Recognition
Were not familiar with the chemicals on the derailed train	**Recall** Remembering from past events or past practices, assimilating to the situation, historical reflection	Recognition
Could not predict how the chemicals would react with each other	**Recall/Comparing** The FF had **no way of knowing** and comparing to a similar situation to make future decisions on evacuating FF or the public.	Comparative Evaluation Assessment Predictive estimations
I couldn't tell what that was going to do to the tunnel	**Bounding** With **limited information**, knowledge and experience, FF **did not know what would occur**. Identification of limitations and constraints to actions.	Constraints Limitations
Wondered what was in the black smoke boiling out of both ends of the tunnel	**Comparing** As assessment of the current information, measuring options against the current information, forecasting, predicting, estimating, hypothesizing	Comparative Evaluation Assessment Predictive estimations

Type of incident that you could not see	**Bounding** **Assessing the situation** was **bounded** because it was in a tunnel. Identification of **limitations and constraints** to actions	Constraints Limitations
Not being able to tell what exactly was burning or even see what the fire looked like left officials in the dark and guessing	**Bounding** **Assessing the situation** was **bounded** because it was in a tunnel. Identification of **limitations and constraints** to actions	Constraints Limitations
There were mainly unknowns	**Bounding** In trying to gain situational awareness of the scene, there were **limitations and constraints** to actions	Constraints Limitations
React only to visible evidence (volume of smoke, color of smoke, intensity of smoke)	**Bounding** Decisions on what to do where based on **limited visuals**	Constraints Limitations
Unfamiliarity of the situation	**Comparing** As assessment of the current information, measuring options against the current information, forecasting, predicting, estimating, hypothesizing	Comparative Evaluation Assessment Predictive estimations
With chemicals, you don't know what your dealing with	**Bounding** Decisions where **confined** because the chemicals **limited actions**.	Constraints Limitations
Could see clouds of black smoke ominously	**Diagnose** Define the situation and making sense of the situation **by visual**.	Sense-making
This had the most potential to be the most devastating event in his experience	**Comparing** The FF was **recalling on past** experience to **compare** how dangerous the situation was.	Comparative Evaluation Assessment Predictive estimations Recognition
City's emergency response plan did not spell out procedures for determining	**Bounding** There was **no guidance** for decisions on what to do for an evacuation	Constraints Limitations
A department manual spelled out the succession of the incident commanders	**Targeting** **Conforming** to a set of predetermined rules or standards	Pre-arranged

They basically knew what I needed before I had to tell them Because everything we were supposed to know about dealing with a situation was being carried out, just like a normal fire	**Recall** At times decisions were not needed, the crews **knew what to do based on past experience,** training.	Recognition
This was no ordinary fire	**Comparing** The FF was **comparing** this situation to past experience in order to decide **what to do next**	Comparative Evaluation Assessment Predictive estimations Recognition
Its just like walking into an oven	**Diagnose** By **assimilating/comparing** the situation to something, information was now registered for decision-making	Sense-making
Evaluate the situation and formulate a plan of attack	**Comparing** As **assessment of the current information**, measuring options against the current information, forecasting, predicting, estimating, hypothesizing	Sensemaking Comparative Evaluation Assessment Predictive estimations
Build a confident decision-making process	**Comparing** **Proactive steps** to make future decisions.	Comparative Evaluation Assessment Predictive estimations
Have somebody go in there and physically get close to the actual incident and assess it, relay the information, continue to build the decision-making model	**Diagnose** The FF needed to **gain situational awareness**	Sense-making Assessment Comparative Evaluation
In the absence of first hand observation, officials fell back on the data available to them from other sources (way bill)	**Bounding** Identification of **limitations and constraints** to actions	Constraints Limitations
Information could be quickly gleaned from the data	**Diagnose** Define the situation and making sense of the situation by describing, classifying visual, textual, and oral, information	Sense-making

SME's were able to offer some reassurance	**Bounding** Where the **information** to make decisions was **not readily available** or known because it was technical situation, the FF fell back on SME's.	Constraints Limitations
After conferring with emergency personnel, decided not to evacuate	**Comparing** A discussion on the decision to evacuate **relied on the people with the most situational awareness**.	Comparative Evaluation Assessment Predictive estimations
Feared a mass exodus could lead to panic	**Comparing** As assessment of the current information, measuring options against the current information, forecasting, predicting, estimating, hypothesizing	Comparative Evaluation Assessment Predictive estimations
A decision made in conjunction with the Mayor's office	**Bounding** The decision to evacuate *required group involvement.*	Constraints Limitations
There was some difference of opinion about which approach to take	**Bounding** Identification of limitations and constraints to actions	Constraints Limitations
Worst case scenario, what do you need?	**Comparing** To make a decision to dedicate additional resources to the incident, it was asked of the FF to predict what they thought how bad it could get	Comparative Evaluation Assessment Predictive estimations
I thought that what was shut down was necessary for safety operations	**Comparing** The decision to shut down traffic was **based on a prediction** that that was the best thing to do.	Comparative Evaluation Assessment Predictive estimations
The smoke from the fire indicated the presence of only carbonaceous material	**Diagnose** The visual contributed to future decisions based on what the FF **recognized** or knew from training.	Recognition Sense-making
From his own inclination that it was better to overreact than under-react	**Recall** Remembering from past events or past practices, assimilating to the situation, historical reflection	Recognition
Unaware of the water main break, they noticed changes to the smoke from black to white	**Diagnose** Define the situation and making sense of the situation by describing, classifying visual, textual, and oral, information	Sense-making

Initially unsure how to interpret	**Comparing** As assessment of the current information, measuring options against the current information, forecasting, predicting, estimating, hypothesizing	Comparative Evaluation Assessment Predictive estimations
The domino effect of events	**Comparing** As assessment of the current information, measuring options against the current information, forecasting, predicting, estimating, hypothesizing	Comparative Evaluation Assessment Predictive estimations
Most had never experienced a crisis of this complexity and duration	**Recall** Remembering from past events or past practices, assimilating to the situation, historical reflection	Recognition
With usual incidents, things begin to go into the decision model within a short period of time. This was not the case.	**Comparing** As assessment of the current information, measuring options against the current information, forecasting, predicting, estimating, hypothesizing	Comparative Evaluation Assessment Predictive estimations
In all my years I never had an incident of that magnitude the required that much coordination	**Recall** Remembering from past events or past practices, assimilating to the situation, historical reflection	Recognition
The scene was confusing	**Diagnose** Define the situation and making sense of the situation by describing, classifying visual, textual, and oral, information	Sense-making
Tried to figure out where to go	**Comparing** The arriving FF crews **had to make a decision** on where to report into **based on what they were faced with upon arrival**.	Comparative Evaluation Assessment Predictive estimations
The situation got more and more convoluted as additional agencies became involved.	**Bounding** Limitations and constraints to actions lead to confusion which clouded decision-making	Constraints Limitations
When we were doing something, everybody had to have buy in	**Bounding** Concurrence on decisions **required time**. Identification of limitations and constraints to actions	Constraints Limitations

The needed contributors were not on hand	**Bounding** Identification of limitations and constraints to actions	Constraints Limitations
Officials were doing there own independent things	**Bounding** Decisions were being made **without consulting others.** Identification of limitations and constraints to actions	Constraints Limitations
There were no formal procedures	**Bounding** **No decision aides**. Identification of limitations and constraints to actions	Constraints Limitations
The process to get permission to do something proved cumbersome	**Bounding** Identification of limitations and constraints to actions	Constraints Limitations
You don't make any decisions without approval	**Bounding** Identification of limitations and constraints to actions	Constraints Limitations
I tried not to apply time pressures	**Bounding** Identification of limitations and constraints to actions	Constraints Limitations

Table 12. 9/11 Pentagon Emergency

Informant's Codes	Analytic Codes	Second Order Categories
The **details of the incident** emerged over days	**Diagnose** The **accumulative information** on the situation progressively contributed to making **better sense** of the situation	Sense-making
Suddenly noticed a plane **He saw** a great flash in the side of the building	**Diagnose** This was a stunning visual that would lead to future decision-making	Sense-making
Start with the most **urgent tasks**	**Sort** Once the incident began to unfold, there were decisions that were needed on **what to do first**	Comparative Evaluation Assessment Predictive estimations
Develop a larger organizational structure as more crews arrived	**Forecast** There was a decision needed to manage the **incident as it got bigger**	Pre-arranged Predictive estimations
Immediate life and death struggle gave way to the longer term campaign	**Predictive estimations** The decision not to save lives yet **look beyond into the future of the incident**	Comparative Evaluation Assessment Predictive estimations
The sheer size of the Pentagon made it hard to get a comprehensive picture of the damage.	**Limited situation awareness** The size of the situation made it difficult in order to make effective decision,	Sense-making Constraints/Limitations
It was possible to see how deeply the plane had penetrated the Pentagon	**Visual awareness**	Sense-making
Used a helicopter to have a global look-down view of the scene He could also see that the fire was huge	**Obtain situation awareness**	Sense-making
Coupled with the knowledge that the Pentagon was constructed of concrete	**Recall** The FF was able to recall on past knowledge	Recognition
Received intelligence that another hijacked plane was heading there way	**Verbal situation awareness**	Sense-making
How many more attacks would there be?	**Forecasting** The FF were unsure of what was	Comparative Evaluation

	unfolding	Assessment Predictive estimations
What were the likely targets?	**Forecasting** The FF were unsure of what was unfolding	Comparative Evaluation Assessment Predictive estimations
In the absence of clear information	**Forecasting** Decisions were still needed to **move the incident forward**, although there was **information ambiguity**	Comparative Evaluation Assessment Predictive estimations
There were stories of an explosion etc.	**Verbal situation awareness**	Sense-making
Given the fact that the terrorists had struck the WTC twice, they though they could be planning a second strike on the Pentagon as well	**Situation awareness** The fire chief need to **take into account** what was **going on outside of the Pentagon** as part of the decision-making	Comparative Evaluation Assessment Predictive estimations
He knew evacuating rescue people would be a controversial decision	**Comparing** The fire chief needed to do some quick **analysis** on how the **decision to evacuate FF would be perceived**	Comparative Evaluation Assessment Predictive estimations
He decided the chances were too high to take the risk and he evacuated the site	**Comparing** After analysis the decision was made to evacuate	Comparative Evaluation Assessment Predictive estimations
Had NY not happened, the notion of another plan hitting the Pentagon wouldn't have been within my scope of reference.	**Comparing** **Comparing** what had happened in NYC to make decisions at the Pentagon	Comparative Evaluation Assessment Predictive estimations
But I did see the second airplane fly into the WTC so it was a scope of my reference	**Situation awareness** **Awareness** via a visual that steered decision-making	Sense-making Comparative Evaluation Assessment Predictive estimations
Because of the chaos, no one was making decisions about how to maximize safety	**Bounding** The situation was driving/limiting decision-making	Constraints Limitations
Nothing in their past emergency response work had prepared them for this	**Recall** The fire crews had not been through anything like this which	Recognition

situation.	limits decision-making abilities.	
The pace of events was too frenetic to allow for a deliberative group process	**Bounding** Decisions were needed quickly by the group of FF, yet the situation could not support	Constraints Limitations
FEMA representatives had a lot of experience with large-scale incidents.	**Recall** The fire chief **deliberated** on who to call for assistance	Comparative Evaluation Assessment Predictive estimations Recognition
I never thought about how to meet nutritional needs of responders	**Forecasting** The fire chief did not know the decision to feed the fire crews snacks as opposed to meals could directly effect fire crews	Comparative Evaluation Assessment Predictive estimations
I was accustomed to incidents that lasted a few hours	**Recall** The fire chief needed to make decisions that **spanned and effected more operational periods**	Recognition
Traditionally he says the commanders left it to the ARC	**Recall** The fire chief **understood** that an SOP was in place on the decision to feed the FF	Recognition
I was just looking for practical solutions. I thought this was the best way to deal with this	**Forecasting** The fire chief was making decisions on the operations of the incident	Comparative Evaluation Assessment Predictive estimations Recognition

Table 13. 9/11 World Trade Center Terrorists Attacks – Fire Department of New York City Operations

Informant's Codes	Analytic code	Second Order Categories
Witnessed the impact of the plane	**Situation awareness** Contributed to the importance of the decisions that needed to be made	Sense-making
Immediately signaled a second alarm….. **Requested additional** resources by transmitting a third alarm	**Recall** Decision on whether there was a need for additional assistance and then using a predetermined SOP to fulfill the request	Recognition Pre-arranged
As the first responding chief, he **established the Incident Command** Post in the lobby, **per FDNY's high-rise firefighting procedures.**	**Targeting** Decision on how to begin managing the incident	Pre-arranged
Incident Command was established and passed (according to protocol) from B1 to the First Division Chief (D1) to the Citywide Tour Commander 4D (CWTC-4D)	**Targeting** Decision on who is in charge	Pre-arranged
Incident Commander **moved the Incident Command Post** from the lobby of WTC 1 to the far side of West Street (an eight lane highway) opposite WTC 1, because of the **increasing risk from falling debris within and around the lobby and other safety concerns.**	**Forecasting** Decision on moving the ICP because of danger	Comparative Evaluation Assessment Predictive estimations
Chief officers **considered** a limited, localized collapse of the towers possible, **but did not think** that they would collapse entirely.	**Forecasting** Considering what the collapse potential was	Comparative Evaluation Assessment Predictive estimations
The Field Communications Unit (Field Com) **set up operations** at the West Street ICP at approximately 9:15 a.m., in accordance with protocols.	**Targeting** Deciding where to set up Field Comm – no direction given	Pre-arranged

Early in the response, **they decided** that **operations** in WTC 1 **should focus on** search and rescue of injured and trapped civilians. In response to specific distress calls (e.g., people stranded in elevators, trapped in rooms, or hurt who would either call 911 or contact OP-1 directly through WTC 1's internal telephone system). To ensure that floors below the fire had been totally evacuated.	**Comparing/Forecasting** Decision on incident priorities	Comparative Evaluation Assessment Predictive estimations
D1 and B1 **directed Port Authority** personnel **to evacuate** surrounding buildings as a precautionary measure.	**Comparing/Forecasting** Decision on further evacuations	Comparative Evaluation Assessment Predictive estimations
several responding units were **unable to reach their staging areas** with their apparatus and therefore **proceeded on foot** directly to the tower lobbies	**Bounding** Decision to abort COA and adjust	Constraints Limitations
Units that failed to stage may have **not received necessary information** and orientation before going into the towers. As a result, several companies that were not from surrounding battalions **had problems differentiating** WTC 1 from WTC 2. Interviews with chief officers in command of the WTC 1 Operations Post indicated that several units that arrived there asked for confirmation of whether they were in the lobby of WTC 1 or WTC 2.	**Situation awareness** Decisions based on poor information	Sense-making Comparative Evaluation Assessment Predictive estimations
Because **information about civilians in distress** continued to reach the Operations Post in the lobby, the chief officers decided to **continue their attempts to evacuate** and rescue civilians, despite the communications	**Situation awareness** Decision on which actions to take	Sense-making Constraints Limitations

difficulties.		
Chief officers in the lobbies of both towers also **had very little reliable information about what was happening outside the towers,** beyond their communications with the ICP. They had **no reliable sources of intelligence and had no external information** about the overall status of the incident area, the condition of the towers or the progression of the fires. For example, they had **no access to television reports** or **reports from an NYPD helicopter** that was hovering above the towers. This **lack of information** hindered their ability to evaluate the overall situation.	**Bounding** Lack of information to make decisions	Constraints Limitations
At approximately 9:30 a.m., personnel in the lobby of WTC 1 **heard an unconfirmed report** of a threat from a third plane. **Due to this announcement** and communications problems that were constraining command and control capabilities, CWTC-4D broadcast over the FDNY tactical radio channel assigned to WTC 1 an **order to all FDNY members to come down to the lobby of WTC 1**. There was no acknowledgement by officers or firefighters of the order.	**Situation awareness** Decision to order MOS out of the building	Sense-making Comparative Evaluation Assessment Predictive estimations
Shortly after the order was given, chief officers in the lobby **learned that the threat of a third plane was false.** At this point, the chiefs continued the search and rescue operations.	**Situation awareness** Decision to continue ops based on information	Sense-making
The **experience** and leadership of these senior chiefs proved crucial to re-establishing command and control after the	**Recall** Decisions based on experience	Recognition

towers collapsed.		
Many believed that a partial collapse within the lobby of WTC 1 had occurred or that the elevators or other debris had fallen into the lobby of WTC 1. The lobby of WTC 1 filled with blinding dust and debris and became untenable. In almost complete darkness, firefighters, officers, chiefs and civilians were **forced to leave the lobby of WTC 1**. Prior to searching for an exit for himself, B1 **issued an order** at approximately 10:00 a.m. over the portable (handier talkie) radio for all FDNY members to evacuate WTC 1	**Bounding** Decision to evacuate MOS based on tangible conditions. In this case an "order" is considered the outcome of a decision.	Sense-making Comparative Evaluation Assessment Predictive estimations
The Department had **no process for evaluating the need for mutual aid,** nor any **formal methods of requesting that aid** or managing it. Therefore, the Department had limited ability to evaluate how mutual aid could be integrated into its operations.	**Bounding** Decision to request assistance – no formal process	Constraints Limitations
These initial mutual aid requests **did not specify** the level and type of resources needed. In addition, the FDNY **did not have adequate information** on the resources and capabilities of departments in surrounding cities and counties (e.g., the size, capabilities and expertise of different units). And, the FDNY had **minimal operational training** with surrounding fire departments, and hence had **limited ability to evaluate** whether and how resources from other departments could be integrated with the FDNY's operations. For instance, it **could not tell whether procedures**	**Bounding** Factors contributing to the inability to make decisions	Constraints Limitations

could be integrated, equipment could interoperate, and whether the capabilities of units with the same names (e.g., rescue or hazmat) were comparable.		
Some potentially **important information** on the structural integrity of the buildings never reached the Incident Commander or the senior FDNY chiefs in the lobbies.	**Bounding** Information need to make decisions	Constraints Limitations
However, the Incident Commander and the chief officers responsible for the operations posts were **required to make decisions** on these matters **lacking some important information**, including: reliable intelligence, media reports, aerial video coverage, or verbal reports from helicopters on the condition of the towers and traffic.	**Bounding** Information need to make decisions	Constraints Limitations
After the buildings collapsed, planning and logistics requirements grew well beyond anything FDNY had experienced before. For instance, the logistics required supporting the search, rescue, and recovery operations after the collapses were massive and unprecedented for the FDNY.	**Bounding** Limited experience	Constraints Limitations

Table 14. 9/11 World Trade Center Terrorists Attacks – New York City Emergency Medical Services Operations

Informant's Codes	Analytic code	Second Order Categories
Upon confirmation that an airplane had flown into WTC 1, the Manhattan Central dispatcher **immediately assigned** ambulance units to the scene and transferred the incident to the EMS citywide dispatcher, **in accordance with EMS protocols**.	**Situation awareness/Targeting** Decision based upon what was transmitted via two-way radio to take action without direction	Sense-making Pre-arranged
He assigned Conditions Car 042 to establish a division on Church Street and decided to move the EMS Command Post to the lobby of WTC 1, next to the Incident Command Post (ICP) that had been established by Fire Operations. (FDNY protocols require that EMS Command report to the Incident Commander. See Exhibit 12 for an EMS command and control events timeline.)	**Targeting** Decision to establish command post locations based on protocol	Pre-arranged
However, as EMS Command moved into the lobby of WTC 1, he was **not immediately aware** that the FDNY Incident Commander (the Chief of Department) was moving the ICP to the far side of West Street, in front of 2 World Financial Center.	**Bounding** Decision outcome failed due to lack of information	Constraints Limitations
EMS chiefs responding to the incident had difficulty communicating over the radio due to the large volume of radio traffic. This **impeded their ability to gain awareness of the overall situation** at the scene.	**Bounding** Situation awareness constrained leading to decision-making paralysis.	Constraints Limitations

On September 11, EMS dispatchers were dealing with **a high volume of information**, a **very large number of responding units, a complex incident response, and a myriad of communications difficulties.** As a result, they were overwhelmed, **limiting their ability to synthesize information** and disseminate it effectively.	**Bounding** Situation awareness and decision-making constrained by the environment	Constraints Limitations
Incident Commander and senior chiefs had a **limited amount of information available to them as they made important decisions**.	**Bounding** Situation awareness constrained	Constraints Limitations
Car 6A and Car 6C (the Tour 1 EMS Chief Officer) would proceed to One Police Plaza, **on the assumption** that responding agencies would be coordinated from that location, given the destruction of the city's Office of Emergency Management (OEM) offices at WTC 7.	**Recall/Forecasting** Decision based on assumption/experience/intuition? Based on definite information. (7WTC)	Recognition Sense-making Comparative Evaluation Assessment
Unknown to those chiefs and officers, other EMS chiefs had already established additional EMS divisions elsewhere.	**Bounding** Information limitations and decisions made unknowingly	Constraints Limitations
Car 4P, also **unaware** of the establishment of divisions at Chelsea Piers and Staten Island Ferry Terminal, immediately established a division at West and Chambers Street.	**Bounding** Decisions made based on unknown information	Constraints Limitations
In all likelihood there was **confusion or misinterpretation** whether EMS personnel were also being recalled when the Chief of Department recalled all Fire personnel.	**Bounding** Decisions based on poor information	Constraints Limitations

Table 15. The 1999 Hurricane Floyd Evacuation in Florida

Informant's Codes	Analytic code	Second Order Categories
A hurricane **as large as any in the State's history** approached	**Recall** Past hurricanes were used to compare to what was about to occur as part of building situation awareness	Recognition Comparative evaluation Sense-making
DEM **believed** they had devised a plan for a large-scale evacuation	**Forecasting** Based on the plan written for this scenario, they believed it would address the forthcoming problems	Predictive estimations
Officials **envisioned** a massive but staged evacuation	**Forecasting** Because the evacuation was yet to start, there was no actual information, and the decision to evacuate was based on predictions on how it would occur	Predictive estimations
Along with the early warnings, this would, **it was thought**, allow time to for an evacuation	**Forecasting** Decision-making was being based on assumptions and predictions	Predictive estimations
Clearance times **proved to be** higher than anticipated	**Diagnose/Comparing** As the evacuation ensued, the actual data was compared to the predicted data which persuaded future decisions	Sense-making Comparative Evaluation Assessment
Because of the **regular threat** of hurricanes and their impact on a state surrounded on three sides by water	**Recall** History has shown what they had been through which influenced evacuation and other decisions	Recognition
No evacuation could be ordered **without an** executive order	**Bounding** Although the decision was made, there were influences via policy	Constraints Limitations
The state OEM alerted local OEMS an state of **emergency was imminent**	**Forecasting** Based on weather forecasts, the decision was made to alert others	Predictive estimations
A wide **range of hurricane scenarios** were **studied**	**Targeting** Specific types of data were sought and used in comparison to the current situation to influence decisions	Pre-arranged Comparative Evaluation
Based on **historical information**, they **could estimate** how many people	**Recall/Compare/Forecasting** Past data compared to the current situation assisted in predicting	Recognition Comparative Evaluation

would evacuate	evacuations	Predictive estimations
The combination **of estimating** the impact of the storm and **estimating** evacuation compliance levels led state officials to **estimate** clearance times	**Forecasting/Compare** Evacuations were based on clearance times, weather data, evacuee behavior to estimate how long it would take	Predictive estimations Comparative Evaluation
Hurricanes **historically** hit Florida with high winds and storm surge	**Recall** The ability to use history influenced decision-making	Recognition
Such surges can inundate low lying areas which **in recent years** have been built up with resorts and new homes	**Recall** On the decision on which areas to evacuate, decision makers were reminded of the recent construction	Recognition
The threat of a hurricane was reinforced by Hurricane Andrew in 1992	**Recall/Compare** The memory of Andrew and comparing that to what was occurring influenced decision-making	Recognition Comparative Evaluation
Floyd **was judged** as larger or potentially more dangerous than even Andrew	**Recall/Compare** The memory of Andrew and comparing that to what was occurring influenced decision-making	Recognition Comparative Evaluation
The decision to evacuate was **based on** the storm's size, track, and intensity	**Targeting** Decision makers sought out specific weather data to raise their situation awareness	Pre-arranged
Fundamental to the state's evacuation efforts was it **use of HRVAC**	**Targeting** Decision makers sought out specific weather data to raise their situation awareness	Pre-arranged
Prior to making the evacuation decision they notified the counties the evacuees would head for shelter	**Forecasting** Foreseeing the outcome on the decision to evacuate residents	Predictive estimations
If we make decisions very broad, we **stand the chance** of putting more people on the roads than the roads can handle	**Forecasting/Comparing/Diagnose** The evacuation decision was influenced by the message that would go out to the residents as a way to minimize shadow evacuations…they compared how many would evacuee	Predictive estimations Comparative Evaluation Assessment

	against what the roadways could handle. Assumed information was analyzed to help make the decision	
In the case of Floyd, the stakes in the evacuation were raised by the **sheer size of the storm**	**Diagnose/Comparing** Decisions were based on what they could decipher and compare	Sense-making Comparative Evaluation Assessment
If officials **based their decision on a storm track** that portended limited impact and evacuation orders were relatively limited, thousands **could be** at risk if the storm actually followed a different track	**Comparing/Diagnose/Forecasting** Evacuation decisions were influenced by weather data	Comparative Evaluation Assessment Predictive estimations
Central to the evacuation decision was the official's **belief**, based on a 72-hour forecasting capacity that the storm would not strike directly.	**Comparing/Diagnose** Weather data was used as a decision-making tool/influencer on evacuations	Comparative Evaluation Assessment
The fact that the storm **might not** come ashore did not mean there was no need for evacuations	**Recall/Forecasting/Diagnose** Decision makers used past experience to realize the storm still had a large potential for destruction	Recognition Predictive estimations Assessment
Officials **expected** that Floyd would have a more powerful effect on central and northeast areas	**Forecasting** Based on weather data	Predictive estimations
They also **believed** that because the first stage of the evacuation would not put many cars on the road, there would still be enough capacity to accommodate the second wave of evacuees.	**Forecasting** It was assumed and decision-making was being based on data not yet available.	Predictive estimations
It was **expected** that the evacuation orders would mean that 1.3 million people would leave there homes.	**Forecasting** The evacuation decision would lead to additional decisions (shelters)	Predictive estimations
The danger from the storm was **thought to** be limited to the coastline. This was a locale in which the storm **would be** a Cat 1 event. As	**Forecasting** Weather data influenced decision-making	Predictive estimations

a result, **officials believed** evacuation should be limited.		
The NWS was **confident the storm would turn.**	**Forecasting/Recall** Weather data influenced their decision-making and their knowledge and experience contributed to decision-making	Predictive estimations Recognition
We had **reason to hope** that those at risk would know who they were.	**Forecasting** Decision makers anticipated residents would understand the threat	Predictive estimations
They were **looking at the image of the storm** and making a decision	**Situation awareness/ Diagnose/Compare** Data was used to examine the size of the storm and establish the severity of the storm	Sense-making Comparative Evaluation Assessment
We were **expecting** that most folks would pretty much stay in their own counties and not go to another county. But they did.	**Forecasting** Decision makers presumed the actions of the evacuees on the evacuation orders	Predictive estimations

Table 16. The 2003 San Diego Firestorm

Informant's Codes	Analytic code	Second Order Categories
The fire quickly **outstripped the capabilities** of the small fire department	**Diagnose/Comparing** Decisions were based on what they could decipher and compare	Sense-making Comparative Evaluation Assessment
Because of the size of the **fire, all vacations were canceled**. Pendleton **requested help** from surrounding communities.	**Forecasting** Sensing the fire was getting bigger	Predictive estimations
They reactivated five of the 10 air tankers that had gone off contract for the rest of the fire season.	**Forecasting** Sensing the fire was getting bigger	Predictive estimations
Before Saturday, the Governor declared a state of emergency	**Forecasting** Sensing the fire was getting bigger	Predictive estimations
As a precaution, fire officials **decided against** lending out any more equipment.	**Forecasting** Sensing the fire was getting bigger	Predictive estimations
Upon arriving on-scene, **fire crews discovered** that the fires location had been misidentified.	**Diagnose** Based on what they were visualizing, the decided to move to another location	Sense-making
Because of the **predictions** for Santa Anna winds the route we would have sent ground forces in would have been compromised by the fire and the ground crews would have been killed.	Deciding not to send crews in because of the situation	Predictive estimations
Therefore, he decided to **wait for daybreak** when he could return with equipment.	**Forecasting** Based on what was known at the time and what was needed in the future a decision was made.	Predictive estimations
The reason we have these **rules** is because pilots couldn't see in the shadows or the smoke.	**Bounding** On a decision to not allow aircraft to fly after dark.	Constraints Limitations
The Sheriff's deputies **decided to order an**	**Diagnose** A decision based on the characteristics	Sense-making Comparative

evacuation.	of the fire	Evaluation Assessment
Firefighters arrived just in time **to keep employees inside the casino** where they waited out the firestorm.	**Diagnose** A decision based on the characteristics of the fire.	Sense-making Comparative Evaluation Assessment
The Cedar fire was **spreading at the rate of** 12,000 acres/hour, a rate of **spread firefighters had never seen before.**	**Comparing** Once they had heard reports on the spread of the fire, they tried to recall fires from the past.	Sense-making Recognition
Despite our expertise, we **did not foresee** how fast this fire would spread…	**Diagnose & Forecasting** They tried to recall past experience to make future determinations.	Recognition Predictive estimations
It was the drought that generated a situation where the fire behaved differently than **anything we'd seen in the past**.	**Recall** Although they were able to recall the reason, they were not able to recall a similar situation.	Recognition
It was very difficult to manage because the **fire was spreading so rapidly**	**Diagnose** Both visuals and what they were hearing hampered decision-making.	Sense-making
The supervisor flew west and decided that **conditions were too windy and smoky for air drops**	**Diagnose** Base on what he visualized, compared to what he knew about air drops in windy conditions, a decision was made.	Sense-making Recognition Comparative Evaluation Assessment
When he **saw the sky** that morning, he knew what it was.	**Recall** Visualizing the sky filled with smoke made sense that the fire was getting closer and decisions on evacuations and operations were needed	Sense-making Comparative Evaluation Assessment
He said he **could not make any decisions** until he could get a committee together	**Bounding** Decision-making progress stalled until an outside entity contributed to the process	Constraints Limitations
We're not going to put up aircraft that **don't have our frequencies** and **don't understand our protocols**	**Bounding** Based on protocols, decisions stalled	Constraints Limitations
I **didn't consider** the use of helicopters because no number of aircraft was going to change the situation.	**Diagnose** On the decision to use aircraft	Recognition

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